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# **AERONAUTICAL ENGINEERING**

A CONTINUING BIBLIOGRAPHY WITH INDEXES



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# Typical Report Citation and Abstract

- ❶ **19970001126** NASA Langley Research Center, Hampton, VA USA
- ❷ **Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes**
- ❸ Gatlin, Gregory M., NASA Langley Research Center, USA Neuhart, Dan H., Lockheed Engineering and Sciences Co., USA;
- ❹ Mar. 1996; 130p; In English
- ❺ Contract(s)/Grant(s): RTOP 505-68-70-04
- ❻ Report No(s): NASA-TM-4663; NAS 1.15:4663; L-17418; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
- ❼ To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10° to 50°, and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall lift characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65° swept forebody serrations tended to roll together, while vortices from 40° swept serrations were more effective in generating additional lift caused by their more independent nature.
- ❽ Author
- ❾ *Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profiles; Aerodynamic Configurations*

## Key

1. Document ID Number; Corporate Source
2. Title
3. Author(s) and Affiliation(s)
4. Publication Date
5. Contract/Grant Number(s)
6. Report Number(s); Availability and Price Codes
7. Abstract
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# AERONAUTICAL ENGINEERING

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*A Continuing Bibliography (Suppl. 365)*

JANUARY 9, 1998

## 01 AERONAUTICS

**19980001231** President's Council on Integrity and Efficiency, Washington, DC USA

**President's Council on Integrity and Efficiency: Combined Report on the Federal Civilian Agencies' Aircraft Management Programs**

Dec. 16, 1996; 46p; In English

Report No.(s): PB97-197289; A43006/O/W-F97011; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Over the course of the past few years, 11 member offices of the President's Council on Integrity and Efficiency (PCIE) have engaged in a multitask project designed to define the current state of management of the Federal civilian agencies' (agencies) aircraft operations, and to report on opportunities to improve current conditions. The purpose of this report is to provide and overview of the PCIE's work and to present our assessment of the current management of the Federal civilian airfleet.

NTIS

*Civil Aviation; Flight Operations; General Aviation Aircraft; Airline Operations*

**19980001632**

**Development of blade profiles for low-pressure turbine applications**

Curtis, E. M., Univ. of Cambridge, UK; Hodson, H. P.; Banieghbal, M. R.; Denton, J. D.; Howell, R. J.; Harvey, N. W.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 531-538; In English; Copyright; Avail: Issuing Activity

This paper describes program of work, largely experimental, which has been undertaken with objective of developing the improved blade profile for low-pressure turbine in aero-engine applications. Preliminary experiments have been conducted using the novel technique. The existing cascade of datum blades has been modified to enable the pressure distribution on suction surface of one of blades to be altered. Various means have been employed to change the geometry of passage. These experiments have provided data used as guide for development of new blade profiles. Results of investigation of the blades are presented and are compared with data on old blades. The results indicate that unsteady effects must be taken into consideration when selecting the blade profile for low-pressure turbine.

Author (EI)

*Low Pressure; Turbine Blades; Turbomachine Blades; Pressure Measurement; Boundary Layers; Wakes*

**19980001828**

**On the role of the lift force in turbulence simulations of particle deposition**

Wang, Q., Univ. of Vermont, USA; Squires, K. D.; Chen, M.; McLaughlin, J. B.; International Journal of Multiphase Flow; August, 1997; ISSN 0301-9322; vol. Volume 23, no. no. 4, pp. 749-763; In English; Copyright; Avail: Issuing Activity

Most calculations of particle deposition in turbulent boundary layers have been performed using an equation of motion in which the form for the lift force is that in a linear shear flow for a particle far from any boundaries, the so-called Saffman formula. Both direct and large eddy simulations of particle deposition in turbulent channel flow have shown that the dependence of the deposition velocity on particle relaxation time is over-predicted using the Saffman force. Since the derivation of the Saffman force there have been more general derivations of the lift on a particle in a shear flow. In this paper an 'optimum' lift force is formulated which represents the most accurate available description of the force acting on a particle in a wall-bounded shear flow. The effect of the force was examined through large eddy simulation (LES) of particle deposition in vertical turbulent channel flow. The optimum force for depositing particles is approximately three times smaller than the lift obtained using the Saffman formula. LES results also show that use of the optimum force yields a dependence of the deposition velocity on particle relaxation time less than

that obtained using the Saffman form and in better agreement with experimental measurements. Neglecting the lift force altogether leads to an even smaller dependence of the deposition velocity on particle relaxation time and is in better agreement with empirical relations, although the deposition rates are smaller than experimental measurements for particles with intermediate relaxation times.

Author (EI)

*Deposition; Turbulent Flow; Particulates; Computerized Simulation; Turbulence*

**19980002032**

**Ozone-rich transients in the upper equatorial Atlantic troposphere**

Suhre, K., UMR CNRS/UPS, France; Cammas, J. -P.; Nedelec, P.; Rosset, R.; Marenco, A.; Smit, H. G. J.; Nature; August 14, 1997; ISSN 0028-0836; vol. Volume 388, no. no. 6643, pp. 661-663; In English; Copyright; Avail: Issuing Activity

High concentrations of ozone are found in the Earth's stratosphere, but strong stratification suppresses efficient exchange of this ozone-rich air with the underlying troposphere. Upward transport of tropospheric trace constituents occurs mainly through equatorial deep convective systems. In contrast, significant downward transport of ozone-rich stratospheric air is thought to take place only outside the tropics by exchange processes in upper-level fronts associated with strong distortions of the tropopause. Ozone within the tropical troposphere is assumed to originate predominantly from ground-based emissions of ozone precursors, particularly from biomass burning, rather than from a stratospheric source. Recent measurements of ozone in the upper troposphere in convective regions over the Pacific Ocean indeed reveal near-zero concentrations. Here we present sharply contrasting observations: ozone-rich (100-500 parts per billion by volume) transients were frequently encountered by specially equipped commercial aircraft at a cruising altitude of 10-12 km (in the upper troposphere) in the vicinity of strong convective activity over the equatorial Atlantic Ocean. This strongly suggests that the input of stratospheric ozone into the troposphere can take place in the tropics. We suggest that this transport occurs either by direct downward movement of air masses or by quasi-isentropic transport from the extratropical stratosphere.

Author (EI)

*Mixing Ratios; Air Pollution; Ozone; Troposphere; Convective Heat Transfer*

## 02

### AERODYNAMICS

*Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.*

**19980000034** National Aerospace Lab., Fluid Dynamics Div., Amsterdam, Netherlands

**Presentation and Analysis of Results of an Unsteady Transonic Wind Tunnel Test on a Semi-Span Delta Wing Model, Oscillating in Pitch**

Geurts, E. G. M., National Aerospace Lab., Netherlands; Oct. 18, 1995; 18p; In English; International Forum on Aeroelasticity and Structural Dynamics, 1995, 26-28 Jun. 1995, Manchester, UK

Report No.(s): PB97-194591; NLR-TP-95523-U; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Wind tunnel data, obtained in the framework of a cooperative U.S. - Dutch program of research are presented and discussed. This Unsteady Transonic Delta Program (UTDP) focuses on two closely related areas: Limit Cycle Oscillations (LCO) on a realistic fighter configuration and unsteady transonic flows about a simple strake (SiS) delta wing. LCO is limited amplitude self-sustaining oscillation produced by a structural/aerodynamic interaction and is generally occurring at (heavy) loaded fighter type wings at transonic speeds; shock induced and trailing edge separation play a dominant role in its development. In this paper flows with phenomena, characteristics for LCO, are analyzed.

NTIS

*Transonic Wind Tunnels; Transonic Speed; Transonic Flow; Self Oscillation; Fighter Aircraft*

**19980000291** National Aerospace Lab., Experimental Aerodynamics Div., Bangalore, India

**Annual Report 1996-1997 of the Experimental Aerodynamics Division Annual Report**

Jun. 1997; 42p; In English

Contract(s)/Grant(s): NAL Proj. E-9-000

Report No.(s): NAL-SP-9711; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The R & D activities of the division are grouped under four major headings: Drag Reduction Technology, Turbulent & Separated Flows, Aircraft & Missile Aerodynamics and Facility Development. Some of the main contributions are summarized.

Author

*Drag Reduction; Turbulent Flow; Separated Flow; Aerodynamic Characteristics*

**19980000332** National Aerospace Lab., Amsterdam, Netherlands

**Flight Testing of a Wing Deflection Measurement Method**

Kannemans, H., National Aerospace Lab., Netherlands; Jun. 8, 1995; 17p; In English; AIAA Atmospheric Flight Mechanics Conference, 7-10 Aug. 1995, Baltimore, MD, USA; Figures in this document may not be legible in mic

Report No.(s): PB97-193239; NLR-TP-95269-U; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A research program has been executed to evaluate candidate wing deflection measurement methods. The following two methods have been selected and flight tested: (1) an optical method based on the use of a video camera to record a black-and-white stripe pattern on the outerwing surface followed by post-flight image processing and (2) an accelerometer method based on the combined use of an accelerometer package located in the wing tip and an inertial reference system located close to the wing root. Results of these two methods are compared. The optical method performs better; accuracies (2 values) have been achieved of 0.08 degrees in twist and 2 mm in heave at the wing tip.

NTIS

*Flight Tests; Displacement Measurement; Wing Tips*

**19980000398** Stanford Univ., Thermosciences Div., Stanford, CA USA

**Flow Over Swept Flaps and Flap Tips Final Report**

Bradshaw, Peter, Stanford Univ., USA; Buice, Carl U., Stanford Univ., USA; Sep. 1995; 11p; In English

Contract(s)/Grant(s): NAG1-1614

Report No.(s): NASA/CR-95-206417; NAS 1.26:206417; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Preliminary measurements have been made of the flow over the tip of an unswept wing flap. to achieve an acceptable Reynolds number based on flap chord, the flap chord was chosen equal to the chord of the main airfoil ( $c = 19$  in. approx. 0.48 m). The model was mounted in a 30 in. x 30 in. wind tunnel running at up to 100 ft/sec. (30 m/s); severe wind-tunnel interference was accepted, and any computations would be done using the tunnel walls as the boundaries of the computational domain. Maximum Reynolds number based on flap chord and tunnel speed was about  $1.0 \times 10^6$ . The grant ended before a full set of measurements could be made, but the work done so far yields a useful picture of the flow. The vortex originates at about mid-chord on the flap and rises rapidly above the chord line. It has a concentrated core, with total pressure lower than the ambient static pressure, and there is no evidence of large-scale wandering. A simple method of model construction, giving light weight and excellent surface finish, was developed.

Author

*Unswept Wings; Wing Flaps; Wind Tunnel Tests; Reynolds Number; Flow Visualization; Flow Measurement*

**19980000580** NASA Lewis Research Center, Cleveland, OH USA

**Scaling Methods for Simulating Aircraft In-Flight Icing Encounters**

Anderson, David N., NASA Lewis Research Center, USA; Ruff, Gary A., Drexel Univ., USA; Oct. 1997; 18p; In English; 2nd; International Symposium on Scale Modeling, 23-27 Jun. 1997, Lexington, KY, USA; Sponsored by International Scale Modeling Committee, Unknown

Contract(s)/Grant(s): RTOP 548-20-23

Report No.(s): NASA-TM-107538; E-10861; NAS 1.15:107538; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper discusses scaling methods which permit the use of subscale models in icing wind tunnels to simulate natural flight in icing. Natural icing conditions exist when air temperatures are below freezing but cloud water droplets are super-cooled liquid. Aircraft flying through such clouds are susceptible to the accretion of ice on the leading edges of unprotected components such as wings, tailplane and engine inlets. to establish the aerodynamic penalties of such ice accretion and to determine what parts need to be protected from ice accretion (by heating, for example), extensive flight and wind-tunnel testing is necessary for new aircraft and components. Testing in icing tunnels is less expensive than flight testing, is safer, and permits better control of the test conditions. However, because of limitations on both model size and operating conditions in wind tunnels, it is often necessary to perform tests with either size or test conditions scaled. This paper describes the theoretical background to the development of icing scaling methods, discusses four methods, and presents results of tests to validate them.

Author

*Ice Formation; Aircraft Icing; Simulation; Scaling; Aircraft Safety*

**19980000600** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Validation of the Chimera Method of the FLU3M Euler Code**

elfahmi, O., Technische Univ., Netherlands; Dec. 1996; 124p; In English

Report No.(s): PB97-190045; Rept-M-743; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

The aim of the current study is to validate the Chimera scheme of the FLU3M Euler code for the prediction of the aerodynamic force and moment coefficients on a body in a supersonic flows. Chapter two of this report describes the Euler equations and their discretization. Chapter three contains the description of the Chimera scheme and the modifications that have been made in the FLU3M Euler code to use the Chimera scheme. Chapter four contains the application of the Chimera scheme on the bi-NACA0012 airfoils, where a grid convergence study is conducted and the different options of the Chimera scheme of FLU3M are compared with each other. In chapter five, the validation of the Chimera scheme of FLU3M is carried out on the Ariane 5 launcher and booster at several positions. Conclusions and recommendations for the use of the Chimera overlapping grids technique to predict the flow past multiple bodies configurations in the supersonic regime are given at the end of this report.

NTIS

*Airfoils; Euler Equations of Motion; Multiblock Grids; Grid Generation (Mathematics); Proving*

**19980000602** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Hypersonic Aerothermodynamic Module for the NLRAERO Program, Part 1, Description and Application**

Cremers, G. G. J., Technische Univ., Netherlands; Dec. 1996; 156p; In English

Report No.(s): PB97-194815; M-748; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

The aerodynamic characteristics of a complex vehicle may be estimated by the NLRAERO program. Hypersonic aerothermodynamics deals with Mach numbers above five. For this specific flow regime, the modified Newtonian method will give fast and accurate results for the pressure distribution on the vehicle's surface. The goals of this study is to extend the NLRAERO program with the hypersonic-flow options, i.e. using the modified Newtonian method. A survey is given of simplified hypersonic local inclination methods and a comparison of their results with experimental results found in the literature. This study resulted in a choice for the method(s) most suitable for specific configurations. Also a thermodynamic model to include viscous effects is described not yet included in the hypersonic module. The implementation of the hypersonic-flow option in NLRAERO is described. The hypersonic-flow option is validated with analytical solutions of the (modified) Newtonian theory for a sphere and a circular pointed cone. As assessment given of the influence of the panelling of the configuration on the accuracy of the results. A number of recommendations is given to further improve the capability of the program.

NTIS

*Aerothermodynamics; Reentry Trajectories; Hypersonic Flow; Computer Programs*

**19980000638** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Five Hole Probe Exploration of the Transonic Vortical Flow Above a Delta Wing**

Oledal, M., Technische Univ., Netherlands; Dec. 1996; 130p; In English

Report No.(s): PB97-190110; Memo-M-736; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The leeward side flow of a 65 deg swept delta wing operating at moderate angles of attack in the transonic speed range has been investigated by means of a fast response five hole probe. Experiments were performed at free stream Mach numbers of 0.6 and 0.8, with angles of attack of 10 deg and 15 deg. Cross-flow planes containing the vortex were measured at 50%, 70%, 140% and 150% of the root chord. The development of total pressure, the static pressure, the flow-wise vorticity and the azimuthal vorticity above and behind the wing are discussed and compared with previous investigations. Above the wing, the measured conical Mach number and density distributions are also presented in order to validate previous and future surface reflective visualization and related optical measurement methods. The current measurements in combination with previous experimental investigations reveal that a shock occur above the wing underneath the vortex at an angle of attack of 15 deg and a Mach number of  $M = 0.8$  at about 65% of the the local semi-span. Further aft, the vortex changes from a jet-like to a wake-like velocity distribution, indicating a change of the flow leading up to vortex breakdown. There are also indications that turbulence or instabilities in the flow play important roles in the development of the time-averaged total pressure close to the vortex core. Some suggestions concerning the interpretation of results from five hole probe surveys in transonic flow are finally presented, together with some proposals for improvements of the azimuthal vorticity calculations.

NTIS

*Delta Wings; Transonic Flow; Flow Visualization; Free Flow; Mach Number; Angle of Attack; Wind Tunnel Tests*

19980001636

**Vortical gust response of a low-solidity vane row including steady loading and dynamic stall effects**

Henderson, G. H., Purdue Univ., USA; Fleeter, S.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 482-490; In English; Copyright; Avail: Issuing Activity

The effects of high steady loading and separated flow on the unsteady aerodynamic response of turbomachine blade rows are experimentally investigated. This is accomplished utilizing a unique single-stage turbomachine research facility in which the flow is not generated by the blading but rather by an additional fan. Thus, for a particular stator incidence angle, the steady or mean stator aerodynamic performance were determined in a completely steady flow with no rotor and also with unsteady flow generated by a rotor composed of perforated plates at the same mean operating condition, thereby identifying the stator vane row dynamic stall conditions. The unsteady aerodynamic response of the very low-solidity stator vane row is then investigated over a range of incidence angle values, including attached and separated flows with dynamic stall.

Author (EI)

*Aerodynamic Stalling; Dynamic Response; Turbomachine Blades; Wind Effects; Loads (Forces); Aerodynamics*

**03**

**AIR TRANSPORTATION AND SAFETY**

*Includes passenger and cargo air transport operations; and aircraft accidents.*

19980000040 Federal Aviation Administration, Washington, DC USA

**Notices to Airmen: Domestic/International**

Jul. 17, 1997; 218p; In English

Report No.(s): PB97-197222; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

Contents include the following: Airway Notams; Airports, Facilities, and Procedural Notams; General FDC Notams; Part 95 Revisions to Minimum En Route IFR Altitudes and Changeover Points; International Notices to Airmen; and Graphic Notes. NTIS

*Airports; Routes*

19980000174 Seagull Technology, Inc., Los Gatos, CA USA

**Conflict Detection and Resolution for Future Air Transportation Management Final Report**

Krozel, Jimmy, Seagull Technology, Inc., USA; Peters, Mark E., Seagull Technology, Inc., USA; Hunter, George, Seagull Technology, Inc., USA; Apr. 1997; 146p; In English

Contract(s)/Grant(s): NAS2-14285

Report No.(s): NASA/CR-97-205944; NAS 1.26:205944; TR-97138-01; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

With a Free Flight policy, the emphasis for air traffic control is shifting from active control to passive air traffic management with a policy of intervention by exception. Aircraft will be allowed to fly user preferred routes, as long as safety Alert Zones are not violated. If there is a potential conflict, two (or more) aircraft must be able to arrive at a solution for conflict resolution without controller intervention. Thus, decision aid tools are needed in Free Flight to detect and resolve conflicts, and several problems must be solved to develop such tools. In this report, we analyze and solve problems of proximity management, conflict detection, and conflict resolution under a Free Flight policy. For proximity management, we establish a system based on Delaunay Triangulations of aircraft at constant flight levels. Such a system provides a means for analyzing the neighbor relationships between aircraft and the nearby free space around air traffic which can be utilized later in conflict resolution. For conflict detection, we perform both 2-dimensional and 3-dimensional analyses based on the penetration of the Protected Airspace Zone. Both deterministic and non-deterministic analyses are performed. We investigate several types of conflict warnings including tactical warnings prior to penetrating the Protected Airspace Zone, methods based on the reachability overlap of both aircraft, and conflict probability maps to establish strategic Alert Zones around aircraft.

Author

*Air Transportation; Management Systems; Free Flight; Safety; Active Control; Air Traffic Control; Decision Support Systems*

19980000201 NERAC, Inc., Tolland, CT USA

**Airborne Collision Avoidance Systems: Traffic Alert (TCAS), Beacon (BCAS), and Cockpit Display (CDTL). (Latest citations from the NTIS Bibliographic Database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-852231



Report No.(s): PB97-852669; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning design, development, and testing of collision avoidance systems involving cockpit displays to alert pilots of conflicting traffic. Three basic approaches are covered in the citations. The first is a Traffic Alert and Collision Avoidance System (TCAS) operating between aircraft equipped with compatible systems. The second is a Beacon Collision Avoidance System (BCAS) which interfaces with FAA traffic controllers, and which makes use of the active mode of the Air Traffic Control Radar Beacon System (ATCRBS). The third system is the Cockpit Display of Traffic Information (CDTI) which is derived from the TCAS-2 system. Systems which involve only ground equipment and controller communication to the pilot are excluded. (Contains 50-250 citations and includes a subject term index and title list.)

NTIS

*Bibliographies; Collision Avoidance; Beacon Collision Avoidance System; Warning Systems; Airborne Equipment*

**19980000304** NERAC, Inc., Tolland, CT USA

**Radar Warning. (Latest Citations from the INSPEC Database)**

Jan. 1997; In English; Page count unavailable. Supersedes PB96-857453

Report No.(s): PB97-854178; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the development and implementation of radar warning instruments and systems. References examine collision warning, collision avoidance, and early warning systems for road vehicles and aircraft. Topics include radar receivers, phased array systems, optoelectronic converters, Doppler weather radar, and directional audio systems. Natural disaster warning systems, airport safety, wind-shear prediction, warning systems for electronic warfare, and market aspects are also considered.

NTIS

*Bibliographies; Radar Receivers; Radar Detection; Product Development; Collision Avoidance; Warning Systems*

**19980000402** Massachusetts Inst. of Tech., Cambridge, MA USA

**Dynamic Flow Management Problems in Air Transportation**

Patterson, Sarah Stock, Massachusetts Inst. of Tech., USA; May 1997; 110p; In English

Contract(s)/Grant(s): NAG2-1088

Report No.(s): NASA/CR-97-206395; NAS 1.26:206395; Copyright Waived; Avail: CASI; A06, Hardcopy; A02, Microfiche

In 1995, over six hundred thousand licensed pilots flew nearly thirty-five million flights into over eighteen thousand U.S. airports, logging more than 519 billion passenger miles. Since demand for air travel has increased by more than 50% in the last decade while capacity has stagnated, congestion is a problem of undeniable practical significance. In this thesis, we will develop optimization techniques that reduce the impact of congestion on the national airspace. We start by determining the optimal release times for flights into the airspace and the optimal speed adjustment while airborne taking into account the capacitated airspace. This is called the Air Traffic Flow Management Problem (TFMP). We address the complexity, showing that it is NP-hard. We build an integer programming formulation that is quite strong as some of the proposed inequalities are facet defining for the convex hull of solutions. For practical problems, the solutions of the LP relaxation of the TFMP are very often integral. In essence, we reduce the problem to efficiently solving large scale linear programming problems. Thus, the computation times are reasonably small for large scale, practical problems involving thousands of flights. Next, we address the problem of determining how to reroute aircraft in the airspace system when faced with dynamically changing weather conditions. This is called the Air Traffic Flow Management Rerouting Problem (TFMRP). We present an integrated mathematical programming approach for the TFMRP, which utilizes several methodologies, in order to minimize delay costs. In order to address the high dimensionality, we present an aggregate model, in which we formulate the TFMRP as a multicommodity, integer, dynamic network flow problem with certain side constraints. Using Lagrangian relaxation, we generate aggregate flows that are decomposed into a collection of flight paths using a randomized rounding heuristic. This collection of paths is used in a packing integer programming formulation, the solution of which generates feasible and near-optimal routes for individual flights. The algorithm, termed the Lagrangian Generation Algorithm, is used to solve practical problems in the southwestern portion of USA in which the solutions are within 1% of the corresponding lower bounds.

Author

*Air Transportation; Flow Distribution; Problem Solving; Flight Paths; Airspace; Congestion; Air Traffic Control; Mathematical Programming; Integers; Inequalities; Linear Programming; Airports*

**19980000405** National Transportation Safety Board, Washington, DC USA

**National Transportation Safety Board Transportation Initial Decisions and Orders and Board Opinions and Orders Adopted and Issued during the Month of January 1997**

Jan. 1997; 360p; In English

Report No.(s): PB97-916701; NTSB/IDBOO-97/01; No Copyright; Avail: Issuing Activity (Nat'l Technical Information Service (NTIS)), Microfiche

The publication contains all Judge Initial Decisions and Board Opinions and Orders in Safety and Seaman Enforcement Cases for January 1997.

NTIS

*Safety Management; Accident Prevention*

**19980000559** NASA Dryden Flight Research Center, Edwards, CA USA

**An Impact-Location Estimation Algorithm for Subsonic Uninhabited Aircraft**

Bauer, Jeffrey E., NASA Dryden Flight Research Center, USA; Teets, Edward, AS and M, Inc., USA; Nov. 1997; 26p; In English  
Contract(s)/Grant(s): RTOP 529-10-04-00-29

Report No.(s): NASA/TM-97-206299; NAS 1.15:206299; H-2200; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An impact-location estimation algorithm is being used at the NASA Dryden Flight Research Center to support range safety for uninhabited aerial vehicle flight tests. The algorithm computes an impact location based on the descent rate, mass, and altitude of the vehicle and current wind information. The predicted impact location is continuously displayed on the range safety officer's moving map display so that the flightpath of the vehicle can be routed to avoid ground assets if the flight must be terminated. The algorithm easily adapts to different vehicle termination techniques and has been shown to be accurate to the extent required to support range safety for subsonic uninhabited aerial vehicles. This paper describes how the algorithm functions, how the algorithm is used at NASA Dryden, and how various termination techniques are handled by the algorithm. Other approaches to predicting the impact location and the reasons why they were not selected for real-time implementation are also discussed.

Author

*Algorithms; Flight Paths; Real Time Operation; Flight Tests; Predictions; Range Safety*

**19980001144** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Lateral Escape Guidance Strategies for Microburst Windshear Encounters**

Visser, H. G., Technische Univ., Netherlands; Feb. 1996; 46p; In English

Report No.(s): PB97-191753; Memo-M-723; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This study presents a preliminary evaluation of several candidate microburst escape guidance strategies, that rely on relatively short range forward-look sensing only. More specifically, three longitudinal guidance laws are developed and evaluated in combination with a single lateral guidance law. The sensor requirements that need to be satisfied in order to permit a practical implementation of the proposed guidance strategies are briefly examined as well. The simulated guidance solutions are then evaluated in terms of recovery-altitude performance and robustness to uncertainty in microburst size and strength. Based on a comparison with exact open-loop optimal solutions, altitude guidance emerged as the most promising longitudinal guidance strategy. The lateral escape strategy, though very simple, proved to be very effective. This report briefly outlines the missing elements, such as providing a framework for future research and development.

NTIS

*Microbursts (Meteorology); Wind Shear; Geostrophic Wind; Barotropic Flow*

**19980001298** NASA Langley Research Center, Hampton, VA USA

**Radiation Safety Issues in High Altitude Commercial Aircraft**

Wilson, John W., NASA Langley Research Center, USA; Cucinotta, Francis A., NASA Langley Research Center, USA; Shinn, Judy L., NASA Langley Research Center, USA; 1995; 4p; In English; 10th; International Congress on Radiation Research, 27 Aug. 1995 - 1 Sep. 1995, Wurzburg, Germany

Contract(s)/Grant(s): RTOP 199-45-16-11

Report No.(s): NASA-TM-112628; NAS 1.15:112628; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

The development of a global economy makes the outlook for high speed commercial intercontinental flight feasible, and the development of various configurations operating from 20 to 30 km have been proposed. In addition to the still unresolved issues relating to current commercial operations (12-16 km), the higher dose rates associated with the higher operating altitudes makes it imperative that the uncertainties in the atmospheric radiation environment and the associated health risks be re-examined. Atmo-

spheric radiation associated with the galactic cosmic rays forms a background level which may, under some circumstances, exceed newly recommended allowable exposure limits proposed on the basis of recent evaluations of the A-bomb survivor data (due to increased risk coefficients). These larger risk coefficients, within the context of the methodology for estimating exposure limits, are resulting in exceedingly low estimated allowable exposure limits which may impact even present day flight operations and was the reason for the CEC workshop in Luxembourg (1990). At higher operating altitudes, solar particles events can produce exposures many orders of magnitude above background levels and pose significant health risks to the most sensitive individuals (such as during pregnancy). In this case the appropriate quality factors are undefined, and some evidence exists which indicates that the quality factor for stochastic effects is a substantial underestimate.

Author

*Commercial Aircraft; High Altitude; Radiation Protection; Atmospheric Radiation; Flight Operations; Exposure; High Speed*

## 04

### AIRCRAFT COMMUNICATIONS AND NAVIGATION

*Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.*

**19980000118** Los Alamos National Lab., NM USA

**Evaluation of habitat use by Rocky Mountain elk (*Cervus elaphus nelsoni*) in north-central New Mexico using global positioning system radio collars**

Biggs, J., Los Alamos National Lab., USA; Bennett, K., Los Alamos National Lab., USA; Fresquez, P. R., Los Alamos National Lab., USA; Apr. 1997; 22p; In English

Contract(s)/Grant(s): W-7405-eng-36

Report No.(s): LA-13279-MS; DE97-005291; No Copyright; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

In 1996 the authors initiated a study to identify habitat use in north-central New Mexico by Rocky Mountain elk (*Cervus elaphus nelsoni*) using global positioning system (GPS) radio collars. They collared six elk in the spring of 1996 with GPS radio collars programmed to obtain locational fixes every 23 h. Between April 1, 1996 and January 7, 1997, they collected >1,200 fixes with an approximately 70% observation rate. They have interfaced GPS locational fixes of elk and detailed vegetation maps using the geographical information system to provide seasonal habitat use within mountainous regions of north-central New Mexico. Based on habitat use and availability analysis, use of grass/shrub and pinon/juniper habitats was generally higher than expected during most seasons and use of forested habitats was lower than expected. Most of the collared elk remained on LANL property year-round. The authors believe the application of GPS collars to elk studies in north-central New Mexico to be a more efficient and effective method than the use of VHF (very-high frequency) radio collars.

DOE

*Rates (Per Time); Observation; Information Systems; High Frequencies; Global Positioning System; Forests*

**19980000126** Los Alamos National Lab., NM USA

**Determination of locational error associated with global positioning system (GPS) radio collars in relation to vegetation and topography in north-central New Mexico**

Bennett, K., Los Alamos National Lab., USA; Biggs, J., Los Alamos National Lab., USA; Fresquez, P. R., Los Alamos National Lab., USA; Feb. 1997; 19p; In English

Contract(s)/Grant(s): W-7405-eng-36

Report No.(s): LA-13252-MS; DE97-005281; No Copyright; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

In 1996, a study was initiated to assess seasonal habitat use and movement patterns of Rocky Mountain elk (*Cervus elaphus nelsoni*) using global positioning system (GPS) radio collars. As part of this study, the authors attempted to assess the accuracies of GPS (non-differentially corrected) positions under various vegetation canopies and terrain conditions with the use of a GPS "test" collar. The test collar was activated every twenty minutes to obtain a position location and continuously uplinked to ARGOS satellites to transfer position data files. They used a Telonics, Inc. uplink receiver to intercept the transmission and view the results of the collar in real time. They placed the collar on a stand equivalent to the neck height of an adult elk and then placed the stand within three different treatment categories: (1) topographical influence (canyon and mesa tops), (2) canopy influence (open and closed canopy), and (3) vegetation type influence (ponderosa pine and pinion pine-juniper). The collar was kept at each



location for one hour (usually obtaining three fixes). In addition, the authors used a hand-held GPS to obtain a position of the test collar at the same time and location.

DOE

*Global Positioning System; Topography; Vegetation; Position (Location)*

**19980000250** Texas Univ., Center for Space Research, Austin, TX USA

**Performance Assessment of Two GPS Receivers on Space Shuttle**

Schroeder, Christine A., Texas Univ., USA; Schutz, Bob E., Texas Univ., USA; May 1996; 136p; In English

Contract(s)/Grant(s): NAG9-750

Report No.(s): NASA/CR-96-206518; NAS 1.26:206518; CSR-96-2; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

Space Shuttle STS-69 was launched on September 7, 1995, carrying the Wake Shield Facility (WSF-02) among its payloads. The mission included two GPS receivers: a Collins 3M receiver onboard the Endeavour and an Osborne flight TurboRogue, known as the TurboStar, onboard the WSF-02. Two of the WSF-02 GPS Experiment objectives were to: (1) assess the ability to use GPS in a relative satellite positioning mode using the receivers on Endeavour and WSF-02; and (2) assess the performance of the receivers to support high precision orbit determination at the 400 km altitude. Three ground tests of the receivers were conducted in order to characterize the respective receivers. The analysis of the tests utilized the Double Differencing technique. A similar test in orbit was conducted during STS-69 while the WSF-02 was held by the Endeavour robot arm for a one hour period. In these tests, biases were observed in the double difference pseudorange measurements, implying that biases up to 140 m exist which do not cancel in double differencing. These biases appear to exist in the Collins receiver, but their effect can be mitigated by including measurement bias parameters to accommodate them in an estimation process. An additional test was conducted in which the orbit of the combined Endeavour/WSF-02 was determined independently with each receiver. These one hour arcs were based on forming double differences with 13 TurboRogue receivers in the global IGS network and estimating pseudorange biases for the Collins. Various analyses suggest the TurboStar overall orbit accuracy is about one to two meters for this period, based on double differenced phase residuals of 34 cm. These residuals indicate the level of unmodeled forces on Endeavour produced by gravitational and nongravitational effects. The rms differences between the two independently determined orbits are better than 10 meters, thereby demonstrating the accuracy of the Collins-determined orbit at this level as well as the accuracy of the relative positioning using these two receivers.

Author

*Space Shuttles; Global Positioning System; Receivers; Ground Tests; Space Transportation System; Robot Arms; Navigation Satellites; Gravitational Effects*

**19980000341** Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

**IGS 1996 Analysis Center Workshop**

Neilan, R. E., Editor, Jet Propulsion Lab., California Inst. of Tech., USA; VanScoy, P. A., Editor, Jet Propulsion Lab., California Inst. of Tech., USA; Zumbege, J. F., Editor, Jet Propulsion Lab., California Inst. of Tech., USA; Oct. 1996; 510p; In English; IGS 1996 Analysis Center Workshop, 19-21 Mar. 1996, Silver Spring, MD, USA; Sponsored by National Oceanic and Atmospheric Administration, USA; Also announced as 19980000342 through 19980000372

Contract(s)/Grant(s): NAS7-1260

Report No.(s): NASA/CR-96-112599; JPL-Publ-96-23; NAS 1.26:112599; No Copyright; Avail: CASI; A22, Hardcopy; A04, Microfiche

Components of the IGS[International GPS (Global Positioning System) Service for geodynamics], have operated a GPS tracking system for several years. The network now contains more than 100 stations and has produced a combined GPS ephemeris that has become the standard for geodesists and geophysicists worldwide. IGS data and products are freely available to all thanks to the cooperation and participation of all the IGS members. The IGS has initiated development of several new products, and technical issues permitting greater accuracy of IGS products have been identified. The IGS convened a workshop on March 1996 in Silver Spring, Maryland, USA, to coordinate these developments and to examine technical problems and solutions. The following topics were addressed: orbit/clock combination; Earth orientation; antenna calibration; SINEX and densification of the International Terrestrial Reference Frame (ITRF) using the GPS; receiver standards and performance; and atmospheric topics.

Author

*Geodynamics; Global Positioning System; Conferences; Geophysics; Geodesy*

**19980000342** Geomatics Canada, Geodetic Survey Div., Ottawa, Ontario Canada

**GPS Orbit/Clock Combinations and Modeling**

Kouba, J., Geomatics Canada, Canada; Beutler, G., Bern Univ., Switzerland; Mireault, Y., Geomatics Canada, Canada; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 3-8; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Since October 1993 a close and productive cooperation between the seven IGS Analysis Centers (ACs) resulted in an unprecedented increase of precision, reliability and the delivery speed of individual AC and combined IGS orbit/clock solutions. Currently the AC and IGS solutions approaching the 5cm(orbital)/0.5ns(clocks) precision are available within hours or days after observations rather than weeks or months. Combinations, comparisons, evaluations and exchange of information within the IGS are essential to continuous improvements of the service. The recent precision advances are mainly due to (a) modeling and analysis innovations and (b) better global deployment of receivers rather than instrumentation improvements as was the case during the initial stages of IGS. The modeling advances and innovations have been brought about by the AC cooperation and competition. With increasing solution precision and processing speed more emphasis should be put on analysis of possible solution biases to increase accuracy. The focus should be on multi-technique comparisons and analyses as individual, single technique solutions for station positions, velocities and EOP are susceptible to systematic effects. The main focus of this position paper is to suggest ways how to increase precision, accuracy and efficiency of the IGS data processing and products. Antenna, tropospheric and ionospheric (error) modeling are not dealt with here as they are addressed in other sessions of this workshop.

Derived from text

*Global Positioning System; Orbital Position Estimation; Clocks*

**19980000343** Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

**Evaluation of IGS Orbits with Satellite Laser Ranging**

Watkins, M. M., Jet Propulsion Lab., California Inst. of Tech., USA; Bar-Sever, Y. E., Jet Propulsion Lab., California Inst. of Tech., USA; Yuan, D. N., Jet Propulsion Lab., California Inst. of Tech., USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 9-12; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A01, Hardcopy; A04, Microfiche

The accuracy with which orbits for the Global Positioning System (GPS) spacecraft, can be computed directly affects the accuracy of the resulting site coordinates and polar motion. Several groups routinely analyze GPS ground tracking data to compute precise orbits and terrestrial reference frame solutions. In this paper, we infer the accuracy of the orbits of two of the GPS satellites by comparing to independent laser ranges of subcentimeter accuracy obtained by a small but reasonably well distributed network of tracking sites. We find that all seven International GPS Service for Geodynamics (IGS) analysis centers achieve range residual root mean square (rms) errors at or below the 100 mm level. The best orbit solutions, from JPL, CODE, and the IGS combined product, yield a residual rms of about 50 mm. These residuals are consistent with three dimensional orbit errors of less than 150 mm. Estimating yaw rates for the spacecraft during shadow events, and using these estimates to compute the laser residual, significantly improves the fit. A small mean residual value of -15 to -30 mm seems to exist for most centers and laser sites which is not fully explained at present, but may be due to uncertainties in the corrections to the laser data, such as the reflector to spacecraft center of mass vector or small reference frame differences between the SLR sites and the GPS orbits.

Author

*Global Positioning System; Geodetic Accuracy; Satellite Orbits; Orbit Calculation*

**19980000344** Bern Univ., Astronomical Inst., Bern, Switzerland

**Using the Extended CODE Orbit Model: First Experiences**

Springer, T. A., Bern Univ., Switzerland; Rothacher, M., Bern Univ., Switzerland; Beutler, G., Bern Univ., Switzerland; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 13-21; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The Extended CODE Orbit Model, an empirical orbit model proposed by Beutler et al. [1994], was used for the first time in the actual parameter estimation procedures (using the Bernese GPS Software), to model the orbits of the GPS satellites at the CODE Analysis Center of the IGS. Apart from six Keplerian elements, this orbit model consists of nine instead of the usual two parameters to take into account the deterministic part of the force field acting on the satellites. In this article, we focus on the optimum use of this Extended CODE Orbit Model for the CODE IGS activities. of particular interest are the generation of rapid orbits, with only 12 hour delays after the last observation, and (IGS) orbit prediction.

Author

*Predictions; Models; Satellite Orbits; Global Positioning System*

**19980000345** National Oceanic and Atmospheric Administration, Geosciences Lab., Silver Spring, MD USA

**GPS Earth Observation Combinations and Results: Session Summaries and Recommendations**

Ray, J. R., National Oceanic and Atmospheric Administration, USA; McCarthy, D. D., Naval Observatory, USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 25-31; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

This session consisted of seven presentations to review the status of current GPS determinations of Earth orientation and to consider further refinements. Brief summaries of each are given in the following sections. The first, by J. Kouba, reported the results of the Analysis Coordinator for the combined IGS time series of daily polar motion (PM) values, a by-product of the regular orbit combinations. J. Ray and D. Gambis et al. gave largely contrasting views of the information content of GPS determinations of Universal Time (UT1) and length-of-day (LOD). The effects of sub-daily Earth orientation variations were discussed by D. McCarthy and T. Herring. In the closing presentation, McCarthy reviewed new standards soon to be adopted by the IERS. The results of this session have been distilled by the participants into a set of six recommendations, which are listed in the final section. These incorporate revisions made based on discussions at the Workshop.

Derived from text

*Global Positioning System; Earth Orientation; Satellite Observation*

**19980000346** Geomatics Canada, Geodetic Survey Div., Ottawa, Ontario Canada

**IGS Combination of GPS Earth Orientation Parameters (EOP)**

Kouba, J., Geomatics Canada, Canada; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 33-42; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

During the IGS Rapid orbit/clock combination, daily GPS based polar motion (PM) values (IERS designation: EOP(IGS)95 P 01) are produced weekly since January 1, 1995 with an 11 day delay. They are computed as weighted means from solutions submitted by the seven IGS Analysis Centers (ACs). Most ACs and the IGS Rapid (IGR) PM solutions have better than 0.5 mas precision, and clearly show smoothing effects in both IERS series (Bulletin A and B) for periods less than 10 days. Similarly, since January 1, 1996, another daily PM series (EOP(IGS)96 P 01) based on the IGS preliminary (IGP) orbit/clock combination is produced daily with only a 1.5 day delay. Currently, six IGS ACs are contributing to this IGP combination. The IGP PM precision is approaching the IGS Rapid PM precision level. These two PM series imply Rx, Ry orientations of the respective IGS orbit combinations. The Rx, Ry orbit rotations can be effectively used to evaluate orbit reference frame and PM consistency of the IGS and individual AC solutions. The orbit/PM consistency has improved slightly during 1995 and it is at, or below 0.1 mas for IGS combined and most AC solutions. The IGR PM combination (EOP(IGS)95 P 01) was compared to the IERS and USNO GPS based PM combinations. All three combined GPS PM series were found to be consistent at the 0.1 mas rms precision level, subject only to small offsets not exceeding 0.4 mas.

Author

*Earth Orientation; Global Positioning System; Parameterization; Polar Orbits; Polar Wandering (Geology)*

**19980000347** National Oceanic and Atmospheric Administration, Geosciences Lab., Silver Spring, MD USA

**GPS Measurements of Length-of-Day: Comparisons with VLBI and Consequences for UT1**

Ray, J. R., National Oceanic and Atmospheric Administration, USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 43-60; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Length-of-day (LOD) estimates from the seven GPS Analysis Centers of the IGS have been compared to values derived from VLBI for a recent 16-month period. All GPS time series show significant LOD biases which vary widely among the Centers. Within individual series, the LOD errors show time-dependent correlations which are sometimes large and periodic. Clear correlations between ostensibly independent analyses are also evident. In the best case, the GPS LOD errors, after bias removal, approach Gaussian with an intrinsic scatter estimated to be as small as approx. 21 microseconds/d and a correlation time constant of perhaps 0.75 d. Integration of such data to determine variations in UT1 will have approximately random walk errors which grow as the square-root of the integration time. For the current best GPS performance, UT1 errors exceed those of daily 1-hour VLBI observations after integration for approx. 3 d. Assuming the stability of LOD biases can be reliably controlled, GPS-derived UT1 can be useful for near real time applications where otherwise extrapolations for several days from the most current VLBI data can be inaccurate by up to approx. 1 ms.

Author

*Global Positioning System; Very Long Base Interferometry; Universal Time; Time Series Analysis; Diurnal Variations*

**19980000348** Observatoire de Paris, France

**Multi-technique EOP Combinations**

Gambis, Daniel, Observatoire de Paris, France; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 61-70; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The IERS Central Bureau regularly combines independent estimates of EOP values, mainly based on SLR, VLBI and GPS, to derive its operational series and also for long-term analysis. The contribution of these 3 techniques to geodynamics is important for their complementarity but also for some aspects linked to redundancy in order to eliminate systematic effects. For polar motion these 3 techniques give approximately the same accuracy (about 0.30 mas). The determination of Universal Time is based on the VLBI technique. Still, satellite techniques (SLR, GPS) give information on the high-frequency UT1 behaviour on time scales limited to a couple of months; this signal can be used for densification of the UT1 series as well as for UT1 extensions on a quasi-real-time basis from the current VLBI available value. In that case errors are limited to about 200 microseconds over one week and 500 over 2 weeks. This represents an improvement of an order of magnitude with respect to the current prediction of UT1.

Author

*Global Positioning System; Universal Time; Very Long Base Interferometry; Earth Orientation*

**19980000349** Naval Observatory, Washington, DC USA

**Daily and Semi-Daily Earth Orientation Parameter Variations and Time Scales**

McCarthy, Dennis D., Naval Observatory, USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 71; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A01, Hardcopy; A04, Microfiche; Abstract Only; Abstract Only

Theoretical models of daily and semi-daily variations in Earth orientation due to tides are now in close agreement. Observations indicate that these variations do exist. It is important that the IGS and IERS agree on a convention for the publication of observations in order to avoid confusion among users of these data. The current practice of the IERS is to provide daily smoothed estimates at 0(sup h) UTC. These contain no daily/semi-daily information. IGS Analysis Centers provide daily estimates of polar motion which do not currently take into account the daily/semi-daily variations in their analyses. Therefore, the observations reported by the IGS Centers may, in fact, contain small systematic errors depending on the length of the arcs used in the orbit determinations. It is recommended that all organizations reporting Earth orientation data provide to the user the information required to transform between a celestial and terrestrial reference frame including the daily/semi-daily variations. The details regarding this problem will be the subject of a forthcoming paper.

Author

*Diurnal Variations; Earth Orientation; Orbit Calculation; Polar Wandering (Geology)*

**19980000350** Naval Observatory, Washington, DC USA

**International Earth Rotation Service Conventions (1996)**

McCarthy, Dennis D., Naval Observatory, USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 73-78; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

The accuracy with which reference systems and Earth orientation data can be defined are limited by the systematic errors which arise in the treatment of astronomical and geodetic observations. Constants and models must be re-evaluated and improved, if possible, as measurement precision improves. Both the astronomical and geodetic communities will maintain sets of conventional standards which change slowly with time as well as "current best estimates" for high-precision users of reference systems. These will be available electronically and updated as required. The International Earth Rotation Service (IERS) Conventions are discussed from the theoretical and applied points of view. Specific constants and models are described.

Author

*Conventions; Earth Rotation; Earth Orientation; Celestial Reference Systems; Inertial Reference Systems*

**19980000351** National Oceanic and Atmospheric Administration, Geosciences Lab., Silver Spring, MD USA

**Calibration of GPS Antennas**

Mader, Gerald L., National Oceanic and Atmospheric Administration, USA; MacKay, J. Ross, National Oceanic and Atmospheric Administration, USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 81-105; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

As geodetic techniques using the Global Positioning System (GPS) continue to improve, the calibration of the antennas used to track GPS data becomes increasingly important. The establishment of the International GPS Service and by several agencies of continuously operating reference stations (CORS) provides a convenient means to incorporate reference network data into a user's solution for either local or regional geodetic baselines. However, the antennas used by these reference networks will very often not be the same as those employed by the user at his end of the baseline. Moreover, different CORS networks may use differ-



ent antennas and different antennas may also be found within the same network. Two antenna characteristics which are frequently not noticed when identical antennas are used, may now become a significant source of error when the antennas at either end of a base line are different. A GPS geodetic solution fundamentally provides the vector between the phase centers of the two antennas. To relate this vector to permanent monuments on the ground, the location of the phase center with respect to an external feature of the antenna structure must be combined with the location of this reference feature with respect to the monument. Since the baseline vector is a relative measurement, errors in phase center location cancel out when identical antennas are used. However, different antennas generally have different phase center locations. Mixed antennas at a minimum require knowledge of the relative positions of the antenna's phase centers and ideally the absolute location of each antenna's phase center. The antenna phase centers defining a baseline vector are actually average phase center locations for the data used to produce that baseline vector. A real antenna does not have a single well-defined phase center. Instead the phase center is a function of the direction from which it receives a signal. For GPS antennas, the dominant variation occurs with elevation. Since baseline measurements usually include GPS observations distributed over all elevations above some cutoff value, this effect may not always be noticeable, even when using mixed antennas. However, these phase center variations with elevation, if large enough, can be noticeable on mixed antenna baselines as an apparent change in height with elevation cutoff. In addition, high precision on longer baselines requires an estimation of the tropospheric scale height along with the baseline components. The estimation of this parameter, which is highly correlated with height, depends on the variation of phase residuals with elevation. If this variation includes an effect that arises from the antennas in addition to that from the troposphere, the scale height parameter, and the height, can be significantly in error. The complete calibration of GPS antennas includes determining this phase center variation as well as the average phase center location.

Derived from text

*Calibrating; Global Positioning System; Phased Arrays; Antennas*

**19980000352** University Navstar Consortium, Boulder, CO USA

#### **Field and Anechoic Chamber Tests of GPS Antennas**

Meertens, C., University Navstar Consortium, USA; Alber, C., University Navstar Consortium, USA; Braun, J., University Navstar Consortium, USA; Rocken, C., University Navstar Consortium, USA; Stephens, B., University Navstar Consortium, USA; Ware, R., University Navstar Consortium, USA; Exner, M., University Corp. for Atmospheric Research, USA; Kolesnikoff, P., Ball Aerospace Systems Div., USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 107-118; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The accuracy of GPS surveys between different GPS antenna types and mounts can be improved using antenna calibration corrections. These corrections range from the 1 mm level to the 100 mm level for commonly used geodetic quality antennas and mounts. In order to calibrate a variety of geodetic antennas and mounts, tests were conducted on short baselines in the field and in a state-of-the art anechoic antenna chamber. Antennas included in the testing, with available IGS names in parentheses, were the Allen Osborne Associates choke ring T (DORNE MARGOLIN T) and AOA Rascal, Ashtech choke ring (DORNE MARGOLIN ASH) with cover installed, Leica SR399 external (EXTERNAL), and Trimble 4000 SST(4000ST LI/L2 GEOD) and Trimble Geod LI/L2 GP (TR GEOD LI/L2 GP) called in this report the SSE or SSI antenna. The results summarized here are described in detail in the UNAVCO Academic Research Infrastructure (ARI).

Author

*Anechoic Chambers; Calibrating; Global Positioning System; Antennas*

**19980000353** Geographical Survey Inst., Tsukuba, Japan

#### **Compact RINEX format and Tools (beta-test version)**

Hatanaka, Yuki, Geographical Survey Inst., Japan; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 121-129; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A data format and software tools are developed for compression of RINEX II observation files based on two basic ideas: (1) eliminate the redundant information by recording only the variation between adjacent epochs for the epoch date time, event flag, satellite list, LLI, and signal strength, and (2) decreasing the digits of the phase, pseudorange, Doppler and receiver clock data by taking 3rd order differences of those data between adjacent epochs. The size of the files can be reduced 1/8 of the original RINEX files by combining with standard file compression commands.

Author

*Global Positioning System; Data Compression; File Maintenance (Computers); Software Development Tools*

**19980000354** Newcastle-upon-Tyne Univ., Dept. of Surveying, Newcastle, UK

**Polyhedron Assembly at Newcastle: Method and Initial Results**

Davies, Philip, Newcastle-upon-Tyne Univ., UK; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 131-143; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A Global Network Associate Analysis Centre of the IGS was established at the University of Newcastle in 1995 as part of the IGS Pilot Project for Densification of the ITRF. With this project now eight months old, this paper describes in detail the analysis method used at Newcastle to create a weekly G-Sinex solution, the Global component of the integrated IGS Polyhedron. A method of attaching Regional networks to the Global component is also proposed. Some statistics summarizing the combined network are presented, and the coordinate repeatability in a recent eleven-week series is assessed and compared to that of the individual Analysis Centre networks. It is found that the median station coordinate standard deviation in the series of free combined networks is 3.6 mm in height and under 3.2 mm horizontally, exceeding any AC network on this statistic. This relies on imposing the IGS requirement for a Global station: that it is estimated by at least three Analysis Centres.

Author

*Densification; Polyhedrons; Global Tracking Network; Network Analysis; Global Positioning System*

**19980000355** GeoForschungsZentrum, Potsdam, Germany

**IGS Tropospheric Estimations**

Gendt, Gerd, GeoForschungsZentrum, Germany; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 147-149; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A01, Hardcopy; A04, Microfiche

Since the monitoring of the atmosphere using the IGS components was first addressed during the 1995 Potsdam Workshop there were a lot of activities on this topic, as examples, the following should be mentioned: (1) quality assessment of water vapor determination using ground based GPS measurements; and (2) establishment of infrastructure and development of software and technology for GPS contributions to weather forecasting. These investigations are of course relevant for climatological studies too. The aim of this session on ground based GPS meteorology was to give an insight into these activities, to get information from possible customers, to discuss the role of IGS within this topic and to define the next steps.

Author

*Estimates; Global Positioning System; Meteorology; Troposphere*

**19980000356** GeoForschungsZentrum, Potsdam, Germany

**Comparison of IGS Troposphere Estimations**

Gendt, Gerd, GeoForschungsZentrum, Germany; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 151-163; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Water vapor is a crucial parameter in atmospheric modeling. It has a very inhomogeneous distribution and a high variability. Continuous and well-distributed measurements of water vapor are therefore of fundamental interest both for short range weather predictions and climatology. The GPS is a cost-effective technology to provide dense, globally distributed and nearly continuously measured water vapor. Even if we get only the (vertical or lateral) integrated values, this is important information.

Author

*Global Positioning System; Water Vapor; Troposphere; Humidity Measurement*

**19980000357** Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

**Strategies for Near Real Time Estimation of Precipitable Water Vapor**

Bar-Sever, Yoaz E., Jet Propulsion Lab., California Inst. of Tech., USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 165-176; In English; Also announced as 19980000341

Contract(s)/Grant(s): NAS7-100; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Traditionally used for high precision geodesy, the GPS system has recently emerged as an equally powerful tool in atmospheric studies, in particular, climatology and meteorology. There are several products of GPS-based systems that are of interest to climatologists and meteorologists. One of the most useful is the GPS-based estimate of the amount of Precipitable Water Vapor (PWV) in the troposphere. Water vapor is an important variable in the study of climate changes and atmospheric convection (Yuan et al., 1993), and is of crucial importance for severe weather forecasting and operational numerical weather prediction (Kuo et al., 1993).

Author

*Global Positioning System; Meteorology; Real Time Operation; Troposphere; Water Vapor; Humidity Measurement*

**19980000358** European Space Agency. European Space Operations Center, EDS at Orbit Attitude Div., Darmstadt, Germany  
**Ionosphere Maps: A New Product of IGS?**

Feltens, J., European Space Agency. European Space Operations Center, Germany; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 177-179; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A01, Hardcopy; A04, Microfiche

The IGS workshop in Silver Spring was the first IGS workshop where a sub-session was dedicated to the ionosphere. The sub-session's aim was to find out how ionosphere products could enter into the IGS service palette. In preparation for this IGS workshop an intercomparison of ionosphere products computed at the different Analysis Centers was organized to provide material for the discussion. A position paper was prepared by J. Feltens, and it was agreed between the different Analysis Centers to concentrate each of their presentations on a special aspect that is relevant to the development of a common IGS product. Accordingly, the topics of the distinct presentations were widely spread: The presentation of CODE concerned the long-term analysis of routinely produced ionosphere maps and experiences made; The presentation of UNB provided an analysis of the effect of shell height on high precision ionosphere modeling; The presentation of JPL dealt with global ionosphere mapping using GPS; A second presentation of JPL pointed out the relevance of GPS/MET data for ionosphere modeling, namely for ionospheric profiling; The presentation of DLR showed comparison results of GPS-derived TEC maps with independent ionospheric probing techniques; and the final presentation, that of ESOC, condensed the first results that came out of the intercomparison and pointed out related aspects of software developments at ESOC. During the discussion that followed the presentations, four points crystallized out as the most important for next steps to progress. These points are listed in the paper.

Derived from text

*Mapping; Earth Ionosphere*

**19980000359** Bern Univ., Astronomical Inst., Bern, Switzerland

**Daily Global Ionosphere Maps Based on GPS Carrier Phase Data Routinely Produced by the CODE Analysis Center**

Schaer, Stefan, Bern Univ., Switzerland; Beutler, Gerhard, Bern Univ., Switzerland; Rothacher, Markus, Bern Univ., Switzerland; Springer, Timon A., Bern Univ., Switzerland; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 181-192; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The Center for Orbit Determination in Europe (CODE) - one of the Analysis Centers of the International GPS Service for Geodynamics (IGS) - produces orbits, Earth orientation parameters, station coordinates, and other parameters of geophysical interest on a daily basis using the ionosphere-free linear combination of the doubly differenced GPS carrier phase observations. Since January 1, 1996, daily global ionosphere maps are routinely estimated as an additional product by analyzing the so-called geometry-free linear combination, which contains the information on the ionospheric refraction. The Total Electron Content (TEC) is developed into a series of spherical harmonics adopting a single-layer model in a sun-fixed reference frame. For each day a set of coefficients is determined which approximates the average distribution of the vertical TEC on a global scale. After re-processing all IGS data of the year 1995, a long-time series of TEC parameters is at our disposal indicating that reasonable absolute TEC determination is possible even when applying an interferometric processing technique. The global ionosphere maps produced are already used in the CODE processing scheme to improve the resolution of the initial carrier phase ambiguities. Spaceborne applications (e.g. altimetry) may benefit from these rapidly available TEC maps. For ionosphere physicists these maps are an alternative source of information about the deterministic and stochastic behavior of the ionosphere, that may be correlated with solar and geomagnetic indices and compared to theoretical models.

Author

*Global Positioning System; Earth Ionosphere; Ionospheric Electron Density; Mapping*

**19980000360** New Brunswick Univ., Dept. of Geodesy and Geomatics Engineering, Fredericton, New Brunswick Canada

**The Effect of Shell Height on High Precision Ionospheric Modeling Using GPS**

Komjathy, A., New Brunswick Univ., Canada; Langley, R. B., New Brunswick Univ., Canada; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 193-203; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

The dispersive nature of the ionosphere makes it possible to measure its total electron content (TEC) using dual-frequency Navstar Global Positioning System (GPS) observations collected by permanent networks of GPS receivers. One such network is that of the International GPS Service for Geodynamics (IGS). UNB has participated in an ionospheric experiment along with other ionospheric research groups under the auspices of the IGS and European Space Agency's European Space Operations Centre (ESA/ESOC). A 5 week long period of dual-frequency GPS measurements collected by IGS stations was designated as a test data set for the different research groups to analyse and produce TEC values and satellite-receiver differential delays. One of the primary goals of the experiment was to analyse the effect of geomagnetic disturbances on the ionospheric products. We have used dual-frequency GPS pseudorange and carrier phase observations from six European stations in the IGS network to derive regional

TEC values and satellite-receiver differential delays. In an earlier study we concluded that after processing data from 6 European stations collected over a 7 day period (the first 7 days of the ionospheric experiment organized by ESA/ESOC), we were able to follow highly varying ionospheric conditions associated with geomagnetic disturbances. We investigated the effect of using different elevation cutoff angles and ionospheric shell heights on the TEC estimates and satellite-receiver differential delays. These results pertaining to GPS week 823 have been presented earlier [Komjathy and Langley, 1996]. In our current research, we used 21 days' worth of data in a continuation of the study mentioned earlier with a more rigorous approach for ionospheric shell height determination which has been derived from the International Reference Ionosphere 1990 (IR190) [Bilitza, 1990]. We looked at the effect of using ionospheric shell heights fixed at a commonly used altitude (400 km) on the TEC and differential delay estimates. We found differences in the differential delays between the two approaches of up to the 0.3 ns (approx. equal to 1 total electron content unit - TECU) level and differences in the TEC estimates up to the 1 TECU (approx. equal to 0.16 m delay on L1) level. We also compared our differential delay estimates with those obtained by other research groups participating in the experiment. We found agreement in the differential delays between three analysis centers at the 1 ns level.

Author

*Electron Density (Concentration); Global Positioning System; Magnetic Disturbances; Magnetic Effects; Earth Ionosphere*

**19980000361** European Space Agency. European Space Operations Center, EDS at Orbit Altitude Div., Darmstadt, Germany  
**Verification of ESOC Ionospheric Modeling and Status of IGS Intercomparison Activity**

Feltens, J., European Space Agency. European Space Operations Center, Germany; Dow, J. M., European Space Agency. European Space Operations Center, Germany; Martin-Mur, T. J., European Space Agency. European Space Operations Center, Germany; Martinez, C. Garcia, European Space Agency. European Space Operations Center, Germany; Bayona-Perez, M. A., European Space Agency. European Space Operations Center, Germany; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 205-219; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

ESOC is planning to extend the use of IGS data also for ionospheric modeling. It is intended to provide ionospheric VTEC models and receiver/satellite differential delay values as new IGS products - besides orbits, earth orientation parameters and station coordinates. Different mathematical models were worked out to represent the ionosphere as single layer. ESOC, during an internal short term analysis of these models, indicated reliable performance. In preparation of the IGS workshop in Silver Spring, a comparison of ionosphere VTEC models originating from different Analysis Centers was organized. This comparison offers the opportunity to verify the modeling and implementations of the participating AC's. ESOC will use the knowledge learned from this comparison, to define its final mathematical modeling and implement it in the Ionosphere Monitoring Facility (IONMON), which is under development at ESOC. Apart from the routine provision of ionospheric products to IGS, it is intended to use the ionosphere models for the support of other ESA missions, e.g. ERS and ENVISAT.

Author

*Earth Ionosphere; Global Positioning System; Proving; Maps*

**19980000362** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Neustrelitz, Germany  
**Comparison of GPS/IGS-derived TEC data with parameters measured by independent ionospheric probing techniques**

Jakowski, N., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Sardon, E., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 221-230; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

In order to evaluate TEC(Total Electron Content)-data products derived from numerous GPS/IGS stations, comparisons are made with ionospheric parameters deduced from independent ionospheric measurements. The study includes data obtained from bottomside and topside vertical ionospheric sounding, NNSS(Navy Navigational Satellite System) radio beacon measurements and incoherent scatter radar probing (EISCAT). The results indicate general physical agreement between the GPS/IGS derived TEC data and the other ionospheric parameters. Furthermore a comparison is made between the GPS-based TEC obtained by different groups using different estimation techniques for the location of the ionosonde station Juliusruh (54.6 deg. N; 13.3 deg. E) during a selected time interval in October, 1995. For the same period, a reference is made to the ionospheric electron content up to 1000 km height deduced from the updated IRI90 model.

Author

*Global Positioning System; Ionospheric Sounding; Electrons; Ionospheric Composition*

**19980000363** Newcastle Univ., Newcastle, UK  
**SINEX: Solution (Software/technique) INdependent EXchange Format Version 1.00**

Blewitt, Geoffrey, Newcastle Univ., UK; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 233-276; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche



SINEX was designed to be modular and general enough to handle GPS as well as other techniques. In particular the information on hardware (receiver, antenna), occupancy and various correspondence between hardware, solution and input files can be preserved, which is essential for any serious analysis and interpretation of GPS results. It preserves input/output compatibility so that output SINEX files can be used (later on) as input into subsequent computation/solutions. It also provides complete information on apriori information so that it can be removed whenever required, making it unnecessary to submit or distribute multiple (SINEX) solution files, e.g. constrained and unconstrained (free) solution files.

Author

*Global Positioning System; Applications Programs (Computers); Data Transfer (Computers)*

**19980000364** Observatoire de Paris, France

**Multi-Technique EOP Combination**

Gambis, D., Observatoire de Paris, France; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 299-305; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

Universal Time solution combined by IERS is mainly based on VLBI inertial techniques. Although space techniques like SLR or GPS have reached a remarkable precision they do not give access to a highly accurate non-rotating reference frame, which restricts the possibility of determining directly UT1 from the processing of their observations. Due principally to uncertainties in the even zonal harmonics and in various models (ocean tides), long-term error drifts are introduced in the node motion and consequently in UT1 of which estimation is completely correlated with the node variations. It is however possible to use the valuable short-term fluctuations given by GPS calibrated with the long-term variations of the solution given by inertial techniques to derive a composite UT1 solution of great interest for its precision and time resolution but also for its economic advantage.

Author

*Global Positioning System; Universal Time; Earth Orientation; Orbit Calculation; Data Correlation*

**19980000365** Bern Univ., Astronomical Inst., Bern, Switzerland

**Antenna Phase Center Offsets and Variations Estimated from GPS Data**

Rothacher, M., Bern Univ., Switzerland; Schaer, S., Bern Univ., Switzerland; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 321-346; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Two types of biases due to antenna differences are discussed. The first is the combination of different antenna types and the second results from long baselines for the same antenna type. The effects of these biases and their impact on IGS are discussed. CASI

*Global Positioning System; Antennas; Instrument Compensation; Data Correlation*

**19980000366** NASA Goddard Space Flight Center, Greenbelt, MD USA

**What are Phase-Center Variations and Why Should I Worry?**

Clark, T. A., NASA Goddard Space Flight Center, USA; Schupler, B. R., Allied-Signal Technical Services Corp., USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 347-367; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A discussion of phase center variations and how they relate to Geodetic Antennas is presented. Antenna range, phase center corrections, and height are incorporated in the discussion.

CASI

*Geodesy; Global Positioning System; Satellite Antennas; Phase Shift*

**19980000367** Massachusetts Inst. of Tech., Cambridge, MA USA

**MIT T2 Analysis Report**

Herring, Thomas A., Massachusetts Inst. of Tech., USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 369-378; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A02, Hardcopy; A04, Microfiche

A report on the different antennas at the analysis centers are presented. RMS errors, center weights, and new GPS sites are reported.

CASI

*Global Positioning System; Satellite Antennas; Performance Tests*

**19980000368** Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

**Ionospheric Profiling using GPS/MET Data**

Hajj, George, Jet Propulsion Lab., California Inst. of Tech., USA; Romans, Larry, Jet Propulsion Lab., California Inst. of Tech.,

USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 379-396; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A report on ionospheric profiling using GPS and MET data is presented. A description of the GPS occultation technique, some examples of GPS/MET data products, the data processing system and a preliminary validation of ionospheric profiles is discussed. CASI

*Global Positioning System; Radio Occultation; Ionospheric Composition; Ionospheric Electron Density; Earth Ionosphere*

**19980000369** Jet Propulsion Lab., California Inst. of Tech., IGS Central Bureau, Pasadena, CA USA

**Global Ionospheric Mapping using GPS: Validation and Future Prospects**

Wilson, Brian D., Jet Propulsion Lab., California Inst. of Tech., USA; Mannucci, Anthony J., Jet Propulsion Lab., California Inst. of Tech., USA; Yuan, Dah-Ning, Jet Propulsion Lab., California Inst. of Tech., USA; Ho, Christian, Jet Propulsion Lab., California Inst. of Tech., USA; Pi, Xiaoqing, Jet Propulsion Lab., California Inst. of Tech., USA; Runge, Tom, Jet Propulsion Lab., California Inst. of Tech., USA; Lindqwister, Ulf J., Jet Propulsion Lab., California Inst. of Tech., USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 397-419; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

Many applications resulting from GPS Mapping are discussed. These include Ionospheric, tropospheric, and space-borne applications. Also included are types of Ionospheric models, examples of GPS maps and the validation of Ionospheric Maps.

CASI

*Atmospheric Models; Earth Ionosphere; Global Positioning System*

**19980000370** National Centers for Environmental Prediction, Environmental Modeling Center, Washington, DC USA

**The Potential Use of GPS/Met in Operational Numerical Weather Prediction**

McPherson, Ronald D., National Centers for Environmental Prediction, USA; Kalnay, Eugenia, National Centers for Environmental Prediction, USA; Lord, Steve, National Centers for Environmental Prediction, USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 421-436; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A discussion of NWP(Numerical Weather Prediction) and the possibility of using GPS/Met data is presented. The existing data base for operational NWP, recent advances in data assimilation and the potential role for GPS/Met is discussed.

CASI

*Global Positioning System; Numerical Weather Forecasting; Atmospheric Models*

**19980000371** Ohio State Univ., Columbus, OH USA

**GPS Orbit Determination Including Various Adjustments (GODIVA)**

Goad, Clyde, Ohio State Univ., USA; Mueller, A., Ohio State Univ., USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 441-456; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

An automated procedure for generating an optimum set of linearly independent ion-free triple differences is presented. In this discussion, the Cholesky decomposition, linear dependency and the efficiency of the procedure is reported.

CASI

*Cholesky Factorization; Global Positioning System; Orbit Calculation*

**19980000372** National Geodetic Survey, Rockville, MD USA

**CORS Project**

Weston, Neil, National Geodetic Survey, USA; IGS 1996 Analysis Center Workshop; Oct. 1996, pp. 457-471; In English; Also announced as 19980000341; No Copyright; Avail: CASI; A03, Hardcopy; A04, Microfiche

A thorough description of the activities within the CORS Project is presented. Its objectives, components, major considerations, station types, coast guard stations, participating observing stations, data collection and special equipment are discussed.

CASI

*Data Acquisition; Geodesy; Meteorology; Atmospheric & Oceanographic Inform Sys*

**19980000394** National Aerospace Lab., Amsterdam, Netherlands

**Evolutionary Computation in Air Traffic Control Planning**

vanKemenade, C. H. M., National Aerospace Lab., Netherlands; Hendriks, C. F. W., National Aerospace Lab., Netherlands; Kok, J. N., Leiden Univ., Netherlands; Hesselink, H. H., National Aerospace Lab., Netherlands; May 03, 1995; 16p; In English; 6th; International Conference on Genetic Algorithms, 15-20 Jul. 1995, Pittsburgh, PA, USA

Report No.(s): PB97-182562; NLR-TP-94565-U; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Air Traffic Control is involved in the real-time planning of aircraft trajectories. This is a heavily constrained optimization problem. We concentrate on free-route planning, in which aircraft are not required to fly over way points. The choice of a proper representation for this real-world problem is non-trivial. The authors propose a two level representation: one level on which the evolutionary operators work, and a derived level on which they do calculations.

NTIS

*Air Traffic Control; Computation; Real Time Operation*

**19980001249** NASA Johnson Space Center, Houston, TX USA

**Wakeshield WSF-02 GPS Experiment Final Report**

Schutz, B. E., Texas Univ., USA; Abusali, P. A. M., Texas Univ., USA; Schroeder, Christine, Texas Univ., USA; Tapley, Byron, Texas Univ., USA; Exner, Michael, University Corp. for Atmospheric Research, USA; McCloskey, Rick, University Corp. for Atmospheric Research, USA; Carpenter, Russell, NASA Johnson Space Center, USA; Cooke, Michael, NASA Johnson Space Center, USA; McDonald, Samantha, NASA Johnson Space Center, USA; Combs, Nick, Houston Univ., USA; Duncan, Courtney, Jet Propulsion Lab., California Inst. of Tech., USA; Dunn, Charles, Jet Propulsion Lab., California Inst. of Tech., USA; Meehan, Tom, Jet Propulsion Lab., California Inst. of Tech., USA; Sep. 1995; 8p; In English

Contract(s)/Grant(s): NCC9-35; NAG9-750; NAGw-977

Report No.(s): NASA/CR-95-206521; NAS 1.26:206521; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Shuttle mission STS-69 was launched on September 7, 1995, 10:09 CDT, carrying the Wake Shield Facility (WSF-02). The WSF-02 spacecraft included a set of payloads provided by the Texas Space Grant Consortium, known as TexasSat. One of the TexasSat payloads was a GPS TurboRogue receiver loaned by the University Corporation for Atmospheric Research. On September 11, the WSF-02 was unberthed from the Endeavour payload bay using the remote manipulator system. The GPS receiver was powered on prior to release and the WSF-02 remained in free-flight for three days before being retrieved on September 14. All WSF-02 GPS data, which includes dual frequency pseudorange and carrier phase, were stored in an on-board recorder for post-flight analysis, but "snap-shots" of data were transmitted for 2-3 minutes at intervals of several hours, when permitted by the telemetry band-width. The GPS experiment goals were: (1) an evaluation of precision orbit determination in a low altitude environment (400 km) where perturbations due to atmospheric drag and the Earth's gravity field are more pronounced than for higher altitude satellites with high precision orbit requirements, such as TOPEX/POSEIDON; (2) an assessment of relative positioning using the WSF GPS receiver and the Endeavour Collins receiver; and (3) determination of atmospheric temperature profiles using GPS signals passing through the atmosphere. Analysis of snap-shot telemetry data indicate that 24 hours of continuous data were stored on board, which includes high rate (50 Hz) data for atmosphere temperature profiles. Examination of the limited number of real-time navigation solutions show that at least 7 GPS satellites were tracked simultaneously and the on-board clock corrections were at the microsec level, as expected. Furthermore, a dynamical consistency test provided a further validation of the on-board navigation solutions. Complete analysis will be conducted in post-flight using the data recorded on-board.

Author

*Global Positioning System; Space Transportation System Flights; Payloads; Remote Manipulator System; Orbit Calculation; Perturbation; Positioning; Atmospheric Temperature; Temperature Profiles*

**19980002153** Eurocontrol Experimental Centre, Bretigny, France

**Conflict-Free Direct Routings in European Airspace**

David, H., Eurocontrol Experimental Centre, France; Mar. 1997; 33p; In English

Report No.(s): PB97-159354; EEC-308; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An ad-hoc simulation model of direct routings in European airspace was used to investigate the frequency of loss of horizontal separation, and to compare methods of flight level allocation to maximize vertical separation. The model demonstrates that, using a pre-defined flight level allocation by heading, one controller, using modern data link and display facilities could provide 'radar separation' for up to twice the present traffic density. Using 'co-ordination' with the existing traffic, a virtually conflict-free direct routing system could be provided for the foreseeable future. The implications of these findings are briefly considered.

NTIS

*Flight Altitude; Air Traffic Control; Airspace; Active Control*

*Includes aircraft simulation technology.*

**19980000044** McDonnell-Douglas Aerospace, Long Beach, CA USA

**A General Interface Method for Aeroelastic Analysis of Aircraft *Final Report***

Tzong, T., McDonnell-Douglas Aerospace, USA; Chen, H. H., McDonnell-Douglas Aerospace, USA; Chang, K. C., McDonnell-Douglas Aerospace, USA; Wu, T., McDonnell-Douglas Aerospace, USA; Cebeci, T., McDonnell-Douglas Aerospace, USA; Feb. 1996; 44p; In English

Contract(s)/Grant(s): NAS2-14091

Report No.(s): NASA/CR-97-206331; NAS 1.26:206331; MDC-96K7062; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The aeroelastic analysis of an aircraft requires an accurate and efficient procedure to couple aerodynamics and structures. The procedure needs an interface method to bridge the gap between the aerodynamic and structural models in order to transform loads and displacements. Such an interface method is described in this report. This interface method transforms loads computed by any aerodynamic code to a structural finite element (FE) model and converts the displacements from the FE model to the aerodynamic model. The approach is based on FE technology in which virtual work is employed to transform the aerodynamic pressures into FE nodal forces. The displacements at the FE nodes are then converted back to aerodynamic grid points on the aircraft surface through the reciprocal theorem in structural engineering. The method allows both high and crude fidelities of both models and does not require an intermediate modeling. In addition, the method performs the conversion of loads and displacements directly between individual aerodynamic grid point and its corresponding structural finite element and, hence, is very efficient for large aircraft models. This report also describes the application of this aero-structure interface method to a simple wing and an MD-90 wing. The results show that the aeroelastic effect is very important. For the simple wing, both linear and nonlinear approaches are used. In the linear approach, the deformation of the structural model is considered small, and the loads from the deformed aerodynamic model are applied to the original geometry of the structure. In the nonlinear approach, the geometry of the structure and its stiffness matrix are updated in every iteration and the increments of loads from the previous iteration are applied to the new structural geometry in order to compute the displacement increments. Additional studies to apply the aero-structure interaction procedure to more complicated geometry will be conducted in the second phase of the present contract.

Author

*Aeroelasticity; Loads (Forces); Mathematical Models; Finite Element Method; Transformations (Mathematics); Computational Grids; Structural Engineering*

**19980000090** Arizona State Univ., Tempe, AZ USA

**Enhanced Multiobjective Optimization Technique for Comprehensive Aerospace Design, Part A *Final Report***

Chattopadhyay, Aditi, Arizona State Univ., USA; Rajadas, John N., Arizona State Univ., USA; 1997; 31p; In English

Contract(s)/Grant(s): NCC2-5150

Report No.(s): NASA/CR-97-206125; NAS 1.26:206125; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A multidisciplinary design optimization procedure which couples formal multiobjectives based techniques and complex analysis procedures (such as computational fluid dynamics (CFD) codes) developed. The procedure has been demonstrated on a specific high speed flow application involving aerodynamics and acoustics (sonic boom minimization). In order to account for multiple design objectives arising from complex performance requirements, multiobjective formulation techniques are used to formulate the optimization problem. Techniques to enhance the existing Kreisselmeier-Steinhauser (K-S) function multiobjective formulation approach have been developed. The K-S function procedure used in the proposed work transforms a constrained multiple objective functions problem into an unconstrained problem which then is solved using the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm. Weight factors are introduced during the transformation process to each objective function. This enhanced procedure will provide the designer the capability to emphasize specific design objectives during the optimization process. The demonstration of the procedure utilizes a computational Fluid dynamics (CFD) code which solves the three-dimensional parabolized Navier-Stokes (PNS) equations for the flow field along with an appropriate sonic boom evaluation procedure thus introducing both aerodynamic performance as well as sonic boom as the design objectives to be optimized simultaneously. Sensitivity analysis is performed using a discrete differentiation approach. An approximation technique has been used within the opti-

mizer to improve the overall computational efficiency of the procedure in order to make it suitable for design applications in an industrial setting.

Author

*Computational Fluid Dynamics; Multidisciplinary Design Optimization; Aerodynamic Characteristics; Sonic Booms; Transformations (Mathematics); Weight (Mass)*

**19980000093** American Inst. of Aeronautics and Astronautics, Reston, VA USA

**Support of AIAA Student Aircraft Design/Fly Competition Final Report, 1 Apr. - 31 Dec. 1997**

Page, Gregory S., American Inst. of Aeronautics and Astronautics, USA; Aug. 01, 1997; 481p; In English

Contract(s)/Grant(s): N00014-97-I-0421

Report No.(s): AD-A329477; Rept-97DBF7501; No Copyright; Avail: CASI; A21, Hardcopy; A04, Microfiche

This report is made up of the combined reports of eight separate teams of students who entered the 1997 Design, Build & Fly Competition. The objectives of the competition were to have student teams design, build and fly unmanned remote control electric aircraft designed for maximum range on a limited battery. A 'fly-off' took place on a private airstrip at Ragged Island, Md., in April 1997. Winners of the contest: 1st place, University of Illinois at Urbana-Champaign; 2nd, Virginia Polytechnic Institute and University; 3rd, Texas A&M University. The Design, Build & Fly Competition was supported by Cessna, the Office of Naval Research and the AIAA Foundation.

DTIC

*Remotely Piloted Vehicles; Aircraft Design; Competition*

**19980000227** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Optimization of Balanced Field Length Performance of Multi-Engine Helicopters: An Application of Non-Linear Programming and Collocation**

Muenninghoff, N., Technische Univ., Netherlands; Jan. 1997; 193p; In English

Report No.(s): PB97-183099; No Copyright; Avail: CASI; A09, Hardcopy; A03, Microfiche

The main objective of this study is to develop a tool that computes complete trajectories, addressing the rejected (TRO) and continued (CTO) flight simultaneously and including the all-engines-operating phase, so that complete balanced field lengths (BFL) are directly optimized. For this purpose, a direct optimization method, based on discretization using collocation is applied. This method is capable of handling discontinuities in a trajectory and inequality boundary and path constraints are easily introduced; moreover, it provides great flexibility in changing or extending problems to consider different operations or conditions.

NTIS

*Nonlinear Programming; Helicopter Performance; Performance Prediction; Collocation*

**19980000428** Federal Aviation Administration, Regulatory Support Div., Oklahoma City, OK USA

**Amateur Built Aircraft Reference Material: OSHKOSH 1997**

1997; 232p; In English

Report No.(s): PB97-194179; No Copyright; Avail: CASI; A11, Hardcopy; A03, Microfiche

Contents include the following: AC 20-27D, Certification and Operation of Amateur-Built Aircraft; AC 21-12A, Application for U.S. Airworthiness Certificate, FAA Form 8130-6; AC 65-23A, Certification of Repairman (Experimental Aircraft Builders); Memorandum, Revised Listing of Eligible Amateur-Built Aircraft Kits; Excerpt from FAA Order 8130.2C, Airworthiness Certification of Aircraft and Related Products; AC 90-89A, Amateur-Built Aircraft and Ultralight Flight Testing Handbook; FAA Form 8130-12, Eligibility Statement Amateur-Built Aircraft (Sample); FAA Form 8400-3, Application for An Airman Certificate and/or Rating (Sample); FAA Form 8130-6, Application for Airworthiness Certificate (Sample); AC 39-7C, Airworthiness Directives; and AC 20-139, Commercial Assistance During Construction of Amateur-Built Aircraft; and AC 103-7, The Ultralight Vehicle.

NTIS

*Aircraft Reliability; Research Aircraft; Flight Crews*

**19980000633** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Identification of SA-330 PUMA Dynamic Models from Flight Test Data in Frequency Domain**

Sridhar, J. K., Technische Univ., Netherlands; Vermerris, R., Technische Univ., Netherlands; Breeman, J. H., National Aerospace Lab., Netherlands; Dec. 1996; 169p; In English

Report No.(s): PB97-190144; Memo-M-733; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche



In this work, it is investigated if the development version of the RSI package can be used for the identification of parametric models for the Puma SA-330 based on short 3211 flight test data records. The RSI package was applied to the real flight test data resulting from the Puma flight test maneuvers. Although the quality of the data base is poor, 8 transfer functions and two SIMO models describing the lateral decoupled dynamics of the helicopter could be identified. The dynamics compared favorably with those found by the WG18 members. Also 4 transfer functions and a MIMO model describing the short period helicopter dynamics were identified. Also, these dynamics compared well with the WG18 results. The models identified with the current version of RSI should be viewed as a black box containing the helicopter dynamics. They can be used to predict helicopter responses.

NTIS

*Dynamic Models; Flight Tests; Sa-330 Helicopter*

**19980000968** NASA Washington, Washington, DC USA

**National Aerospace Plane Thermal Development. (Latest citations from the Aerospace Database)**

Jun. 1997; In English; Page count unavailable. Supersedes PB96-864202

Report No.(s): NASA/TM-97-113072; NAS 1.15:113072; PB97-860860; No Copyright; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning thermal properties of the National Aerospace Plane (NASP). Analysis of thermal stress, and methods for determining thermal effects on the plane's supersonic structure are discussed. The citations also review temperature extremes that the vehicle is likely to encounter.

NTIS

*National Aerospace Plane Program; Thermodynamic Properties; Aerospace Planes*

**19980001060** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Conceptual Design of a 70 Passenger Airliner Propelled by Fuel-Efficient Turbofan Engines**

Fransen, S. H. J. A., Technische Univ., Netherlands; 1997; 26p; In English; GARTEUR A.G. Meeting, 19-20 Mar. 1996, Bremen, Germany

Report No.(s): PB97-191761; Memo-M-725; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The conceptual design process of a regional transport airliner, intended to carry a design pay-load of 70 passengers plus baggage over a distance of 2500 km, is described. Different aircraft are designed to allow a discrete variation on the primary design variable, which is the wing aspect ratio. To limit the amount of changes in the overall aircraft design, it was decided that the fuselage and tail design should be the same under variation of the aspect ratio. Also, the wing design will be different for the 6 designs and wing position might vary as well. The aircraft is to be optimized for maximum range and direct operating cost. In the design procedure, the maximum take-off weight will be kept constant. Finally, the wing area should be constant as well, which implies a certain constant wing loading has to be chosen for the family of 6 designs. Different optimum aspect ratios for maximum range and DOC are derived.

NTIS

*Turbofan Engines; Aircraft Design; Fuselages; Loads (Forces); Operating Costs; Transport Aircraft*

**19980001065** NERAC, Inc., Tolland, CT USA

**Lighter Than Air Vehicles: Latest Citations from the NTIS Bibliographic Database**

Jan. 1997; In English

Report No.(s): PB97-854400; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the design and applications of balloons, dirigibles, and airships. Citations focus on passenger or cargo transport, timbering, and fabric selection. Meteorological balloons are excluded. (Contains 50-250 citations and includes a subject term index and title list.)

NTIS

*Bibliographies; Airships; Balloons*

**19980001088** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Comparison of Prediction Error and Subspace Identification Methods: Aircraft and Helicopter Applications**

Visser, J., Technische Univ., Netherlands; Sridhar, J. K., Technische Univ., Netherlands; Mulder, J. A., Technische Univ., Netherlands; Jan. 1996; 43p; In English

Report No.(s): PB97-191738; Memo-M-720; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

In this report, two prediction error minimization algorithms to the identification of controlled autoregressive or ARX- and controlled autoregressive moving average or ARMAX-models are discussed. Also, two subspace methods discussed, the multivariable output-error state space model identification based on past output or MoespPO and the numerical algorithms for subspace state space system identification or N4SID. These algorithms are used to identify a hairdryer, the out of plane bending of a helicopter rotorblade, and the symmetrical dynamics of an aeroplane. For the last application only, the subspace methods are discussed.

NTIS

*Helicopters; Optimization; Error Analysis; Autoregressive Moving Average*

**19980001126** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**MIMO Identification Techniques and Software Development in the Frequency Domain for Helicopter and Flexible Aircraft Progress Report, 1995**

Sridhar, J. K., Technische Univ., Netherlands; Breeman, J. H., National Aerospace Lab., Netherlands; Mulder, J. A., Technische Univ., Netherlands; Jan. 1996; 11p; In English

Report No.(s): PB97-191696; Memo-M-715; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report summarizes the progress made during the year 1995 under the contract/project reference number 5-83402 dated 8 February 94 between NLR and TUD. In addition, the report also gives a brief account of the work remaining and work planned for 1996.

NTIS

*Computer Programming; Flexible Wings; Helicopters; MIMO (Control Systems)*

**19980001127** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**MIMO Identification Techniques and Software Development in the Frequency Domain for Helicopter and Flexible Aircraft: Technical Results, 1995**

Sridhar, J. K., Technische Univ., Netherlands; Breeman, J. H., National Aerospace Lab., Netherlands; Mulder, J. A., Technische Univ., Netherlands; Jan. 1996; 59p; In English

Report No.(s): PB97-191704; Memo-M-716; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The report summarizes the progress made during the year 1995 under the contract/project reference number 5-83402 dated 8 February 94 between NLR and TUD. In addition, the report also gives a brief account of the work remaining and work planned for 1996.

NTIS

*MIMO (Control Systems); Helicopters; Computer Programming*

**19980001224** National Aerospace Lab., Amsterdam, Netherlands

**Reynolds- and Mach-Number Effects and 2D-3D Correlation Based on Measurements and Computed Results for the Gar-teur Take-Off Configuration**

Arlinger, B. G., Saab Aircraft Co., Sweden; Larsson, T., Saab Aircraft Co., Sweden; Arnold, F., Daimler-Benz Aerospace A.G., Germany; Earnshaw, P. B., Defence Research Agency, UK; Moens, F., Office National d'Etudes et de Recherches Aeronautiques, France; Saliveros, E., British Aerospace Airbus Ltd., UK; Termes, A. P. P., National Aerospace Lab., Netherlands; Feb. 24, 1995; 20p; In English; The High Lift and Separation Control/CEAS European Forum, 29-31 Mar. 1995, Bath, UK

Report No.(s): PB97-178842; NLR-TP-95106-U; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The research program of the GARTEUR High Lift Phase 3 Action Group AD (AG-13) comprised the analysis of 2D and 3D experimental data and investigation of the reliability of modern numerical calculation methods. Reynolds- and Mach-number effects were analyzed and the correlation of 2D-3D results were studied. Major Reynolds number effects on the experimental parameters are observed for Re less than or equal to 6 million. Major Mach number effects are observed for M greater than or equal to 0.22 when a weak shock occurs on the slat, affecting the slat wake and main wing boundary layer confluence location and consequently the lift. Surface roughness, external devices in the wind tunnel and structural model deformations affect the experimental results significantly.

NTIS

*Reynolds Number; Mach Number; Wind Tunnel Tests; Surface Roughness; Numerical Analysis; Boundary Layers*

**19980001238** NERAC, Inc., Tolland, CT USA

**Military Helicopters. (Latest Citations from the Ei Compendex\*Plus Database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-856562

Report No.(s): PB97-853998; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the design, development, and testing of military helicopters. Topics include helicopter airworthiness, design and flight testing, flight mechanics, structures, propulsion, avionics, human factors, V/STOL and advance concepts, and noise and vibration problems. (Contains 50-250 citations and includes a subject term index and title list.)  
NTIS

*Bibliographies; Military Helicopters; Helicopter Design; Flight Tests*

**19980001246** NERAC, Inc., Tolland, CT USA

**Adaptive Vibration Control Systems. (Latest citations from the NTIS Bibliographic Database)**

Apr. 1997; In English; Page count unavailable. Supersedes PB96-857776

Report No.(s): PB97-858351; No Copyright; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the design, development, evaluation, and applications of adaptive vibration control systems. Adaptive and active vibration control for space structures and aircraft are examined. Citations discuss large scale space structure, helicopter rotor vibration, flexible structures, piezoelectric active actuators, active flutter suppression, and vibration noise reduction and control algorithms. (Contains 50-250 citations and includes a subject term index and title list.)  
NTIS

*Bibliographies; Adaptive Control; Vibration Damping; Active Control*

## 06

### AIRCRAFT INSTRUMENTATION

*Includes cockpit and cabin display devices; and flight instruments.*

**19980000444** NERAC, Inc., Tolland, CT USA

**Radar Altimeters. (Latest citations from the INSPEC Database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-850821

Report No.(s): PB97-852396; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the operational principles, design, and applications of radar altimeters. The use of laser, pulse-limiting, microwave, synthetic aperture, and FM-CW altimeters in the measurement of ice sheets, wind, ocean surface, land features, and rain is examined. The calibration, resolution, and performance of various systems are considered, and specific measurement operations are described.

NTIS

*Bibliographies; Radio Altimeters; Design Analysis; Ice; Wind Measurement; Ocean Surface; Rain*

**19980001109** NERAC, Inc., Tolland, CT USA

**Head Up Displays. (Latest Citations from the Aerospace Database)**

Jan. 1997; In English; Page count unavailable. Supersedes PB96-859111

Report No.(s): PB97-854525; NASA/CR-97-112946; NAS 1.26:112946; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)); US Sales Only, Microfiche

The bibliography contains citations concerning the design, fabrication, and applications of head up displays (HUDs). Applications include military aircraft, helicopters, space shuttle, and commercial aircraft. Functions of the display include instrument approach, target tracking, and navigation. The head up display provides for an integrated avionics system with the pilot in the loop. (Contains 50-250 citations and includes a subject term index and title list.)  
NTIS

*Bibliographies; Head-Up Displays*



**19980001257** National Aerospace Lab., Amsterdam, Netherlands

**Avionics System Approach for Future Civil Aviation**

Abbink, F. J., National Aerospace Lab., Netherlands; Jun. 19, 1995; 58p; In English; 1994 ERA Technology Avionics Conference and Exhibition, 30 Nov. - 1 Dec. 1994, Heathrow, UK

Report No.(s): PB97-193247; NLR-TP-95286-U; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Air transport will further expand in the next two decades. New airliners, runways, passenger terminals and computer assisted or automated Air Traffic Control (ATC) systems will be necessary to accommodate the increasing traffic. The new ATC systems will require computer assisted planning, digital data links between ATC computers and aircraft computer systems and improved worldwide communication, navigation and surveillance systems (partly satellite-based). To further improve safety levels, apart from improved ATC infrastructure, training and procedures, also an enhanced 'safety net' of warning systems to alert the pilot for imminent ground collision, windshear and mid-air collision will have to be developed. Finally the Man-Machine Interface (based on Synthetic and Enhanced Vision) will have to be developed to provide improved situational awareness and enable quick interpretation of and reaction to warning signals as well as to allow safe operation to and from minimally equipped airports.

NTIS

*Civil Aviation; Warning Systems; Safety; Midair Collisions; Digital Data; Data Links; Commercial Aircraft; Automatic Control; Airborne/Spaceborne Computers*

**07**

**AIRCRAFT PROPULSION AND POWER**

*Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.*

**19980000181** NASA Lewis Research Center, Cleveland, OH USA

**Elevated Temperature Ballistic Impact Testing of PBO and Kevlar Fabrics for Application in Supersonic Jet Engine Fan Containment Systems**

Pereira, J. Michael, NASA Lewis Research Center, USA; Roberts Gary D., NASA Lewis Research Center, USA; Revilock, Duane M., Jr., NASA Lewis Research Center, USA; Nov. 1997; 10p; In English

Contract(s)/Grant(s): RTOP 537-04-26

Report No.(s): NASA-TM-107532; NAS 1.15:107532; E-10852; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Ballistic impact tests were conducted on fabric made from both Poly(phenylene benzobizoxazole) (PBO) and Kevlar 29 which were selected to be similar in weave pattern, areal density, and fiber denier. The projectiles were 2.54-cm- (1-in.-) long aluminum cylinders with a diameter of 1.27 cm (0.5 in.). The fabric specimens were clamped on four sides in a 30.5-cm- (12-in.-) square frame. Tests on PBO were conducted at room temperature and at 260 C (500 F). A number of PBO specimens were aged in air at 204 and 260 C (400 and 500 F) before impact testing. Kevlar specimens were tested only at room temperature and with no aging. The PBO absorbed significantly more energy than the Kevlar at both room and elevated temperatures. However, after aging at temperatures of 204 C (400 F) and above, the PBO fabric lost almost all of its energy absorbing ability. It was concluded that PBO fabric is not a feasible candidate for fan containment system applications in supersonic jet engines where operating temperatures exceed this level.

Author

*Impact Tests; Fabrics; Aging (Materials); Energy Absorption*

**19980000564** NERAC, Inc., Tolland, CT USA

**Aircraft Gas Turbine Engines: Noise Reduction and Vibration Control. (Latest citations from Information Services in Mechanical Engineering Database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-853056

Report No.(s): PB97-853337; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the design and analysis of aircraft gas turbine engines with respect to noise and vibration control. Included are studies regarding the measurement and reduction of noise at its source, within the aircraft, and on the ground. Inlet, nozzle and core aerodynamic studies are cited. Propfan, turbofan, turboprop engines, and applications in Short Take-Off and Landing (STOL) aircraft are included.

NTIS

*Bibliographies; Aircraft Engines; Noise Reduction; Turbofan Engines; Noise Measurement*

**19980000881** NERAC, Inc., Tolland, CT USA

**Ceramics Technology: Aircraft Engine Component Applications. (Latest citations from the Ei Compendex\*Plus database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-853031

Report No.(s): PB97-852917; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning ceramic materials that are resistant to heat, wear, and corrosion processes, and their use in aircraft engines. Fabrication techniques for ignition system components, combustion chamber parts, gas-path seals, turbine rotors, stators, nozzles, blades, and heat exchangers are discussed. Ceramic metal composites suitable for aircraft gas turbine engine components are also considered.

NTIS

*Bibliographies; Gas Turbine Engines; Aircraft Engines; Jet Engines; Ceramics; Ignition Systems; Ceramic Matrix Composites*

**19980001638**

**Experimental study of tip clearance losses and noise in axial turbomachines and their reduction**

Kameier, F., BMW Rolls-Royce Aeroengines, Germany; Neise, W.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 460-471; In English; Copyright; Avail: Issuing Activity

An experimental study is described to investigate the negative effects of the tip clearance gap on the aerodynamic and acoustic performance of axial turbomachines. In addition to the increased broadband levels reported in the literature when the tip clearance is enlarged, significant level increases were observed within narrow frequency bands below the blade passing frequency. Measurements of the pressure and velocity fluctuations in the vicinity of the blade tips reveal that the tip clearance noise is associated with a rotating flow instability at the blade tip, which in turn is only present under reversed flow conditions in the tip clearance gap. A turbulence generator inserted into the tip clearance gap is found to be effective in eliminating the tip clearance noise and in improving the aerodynamic performance.

Author (EI)

*Axial Flow; Turbomachinery; Aerodynamics; Acoustics; Turbomachine Blades*

## 08

### AIRCRAFT STABILITY AND CONTROL

*Includes aircraft handling qualities; piloting; flight controls; and autopilots.*

**19980000641** Technische Univ., Div. of Applied Mathematics, Delft, Netherlands

**MIMO Identification Techniques and Software Development in the Frequency Domain for Helicopter and Flexible Aircraft Progress Report, 1996**

Sridhar, J. K., Technische Univ., Netherlands; Breeman, J. H., National Aerospace Lab., Netherlands; Mulder, J. A., Technische Univ., Netherlands; Dec. 1996; 13p; In English

Report No.(s): PB97-183115; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report summarizes the progress made during the year 1996 under the contract/project reference number 5-83402 dated 8 February 94 between NLR and TUD. This is the concluding report (M-772) of the project.

NTIS

*MIMO (Control Systems); Helicopters; Flexible Wings; Parameter Identification; Control Systems Design; Software Engineering; Computer Programs*

**19980001023** NASA Langley Research Center, Hampton, VA USA

**Application of Wind Tunnel Free-Flight Technique for Wake Vortex Encounters**

Brandon, Jay M., NASA Langley Research Center, USA; Jordan, Frank L., Jr., NASA Langley Research Center, USA; Stuever, Robert A., NASA Langley Research Center, USA; Buttrill, Catherine W., Unisys Corp., USA; Nov. 1997; 74p; In English  
Contract(s)/Grant(s): RTOP 505-64-13-15

Report No.(s): NASA-TP-3672; NAS 1.60:3672; L-17462; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

A wind tunnel investigation was conducted in the Langley 30- by 60-Foot Tunnel to assess the free-flight test technique as a tool in research on wake vortex encounters. A typical 17.5-percent scale business-class jet airplane model was flown behind a stationary wing mounted in the forward portion of the wind tunnel test section. The span ratio (model span-generating wingspan) was 0.75. The wing angle of attack could be adjusted to produce a vortex of desired strength. The test airplane model was success-

fully flown in the vortex and through the vortex for a range of vortex strengths. Data obtained included the model airplane body axis accelerations, angular rates, attitudes, and control positions as a function of vortex strength and relative position. Pilot comments and video records were also recorded during the vortex encounters.

Author

*Wakes; Vortices; Wind Tunnel Tests; Free Flight*

**19980001066** NERAC, Inc., Tolland, CT USA

**Hardware-in-the-Loop Simulation. Aerospace and Military Systems Applications: Latest Citations from the INSPEC Database**

Jan. 1997; In English

Report No.(s): PB97-854426; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the testing of complex computerized systems for missile, aircraft, and aerospace systems used in navigation, guidance, and control. Hardware-in-the-loop simulation involves operation of an actual piece of hardware such as the inertial system or seeker elements during real-time simulation of the missile flight control computer and its software algorithms. Such techniques and facilities may eventually be used in the automotive industry for the development of anti-lock braking systems and other complex controls. (Contains 50-250 citations and includes a subject term index and title list.)

NTIS

*Bibliographies; Control Simulation; Computerized Simulation; Computer Techniques; Flight Control*

## 09

### RESEARCH AND SUPPORT FACILITIES (AIR)

*Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.*

**19980000395** NERAC, Inc., Tolland, CT USA

**Anechoic Chambers: Aerospace Applications. (Latest Citations from the Aerospace Database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-855689

Report No.(s): PB97-853725; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the design, development, performance, and applications of anechoic chambers in the aerospace industry. Anechoic chamber testing equipment, techniques for evaluation of aerodynamic noise, microwave and radio antennas, and other acoustic measurement devices are considered. Shock wave studies on aircraft models and components, electromagnetic measurements, jet flow studies, and antenna radiation pattern measurements for industrial and military aerospace equipment are discussed. (Contains 50-250 citations and includes a subject term index and title list.)

NTIS

*Bibliographies; Anechoic Chambers; Design Analysis; Performance Tests*

**19980000557** MSE Technology Applications, Inc., Butte, MT USA

**Magnetohydrodynamics Accelerator Research Into Advanced Hypersonics (MARIAH), Part 1 Final Report, Apr. 1995 - Oct. 1997**

Micheletti, David A., MSE Technology Applications, Inc., USA; Baughman, Jack A., MSE Technology Applications, Inc., USA; Nelson, Gordon L., MSE Technology Applications, Inc., USA; Simmons, Gloyd A., MSE Technology Applications, Inc., USA; Oct. 1997; 650p; In English

Contract(s)/Grant(s): DE-AC22-96EW-96405; NASA Order A-45416-D

Report No.(s): NASA/CR-97-206242-Pt-1; NAS 1.26:206242-Pt-1; MSE-029-Pt-1; No Copyright; Avail: CASI; A99, Hardcopy; A06, Microfiche

This report documents the activities, results, conclusions and recommendations of the Magnetohydrodynamics Accelerator Research Into Advanced Hypersonics (MARIAH) Project in which the use of magnetohydrodynamics (MHD) technology is investigated for its applicability to augment hypersonic wind tunnels. The long range objective of this investigation is to advance the development of ground test facilities to support the development of hypervelocity flight vehicles. The MHD accelerator adds kinetic energy directly to the wind tunnel working fluid, thereby increasing its Mach number to hypervelocity levels. Several techniques for MHD augmentation, as well as other physical characteristics of the process are studied to enhance the overall performance of hypersonic wind tunnel design. Specific recommendations are presented to improve the effectiveness of ground test facilities. The work contained herein builds on nearly four decades of research and experimentation by the aeronautics ground test and evaluation community, both foreign and domestic.

Author

*Magnetohydrodynamics; Hypersonics; Plasma Jet Wind Tunnels; Shock Tunnels; Plasma Accelerators; Hypersonic Speed*

**19980000842** Army Research Lab., Aberdeen Proving Ground, MD USA

**Construction and Testing of the ARL 1.68-m Diameter Shock Tube Exit Jet Spreader for Non-Ideal Blast Simulation *Final Report***

Condon, John A., Army Research Lab., USA; Lottero, Richard E., Army Research Lab., USA; Loucks, Richard B., Army Research Lab., USA; Jun. 1997; 71p; In English

Contract(s)/Grant(s): DA Proj. 1L1-62618-AH-80

Report No.(s): AD-A328934; ARL-TR-1336; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The U.S. Army Research Laboratory (ARL) has demonstrated the feasibility of fusing the modified exit jet of a simple shock tube to simulate high dynamic pressure air blast flows such as those that occur in non-ideal nuclear blast events. These flows can be used to generate simulated non-ideal blast loads on Army equipment with the intent of evaluating and improving its survivability. This work has included the use of small, intermediate, and large scale shock tubes to which exit jet spreader devices were incorporated. These spreaders were mounted at the ends of the shock tubes but were not directly connected to them. Their purpose was to spread the exit jets and their associated dynamic pressure impulses more uniformly over a greater area, thus providing a more accurate simulation capability for testing larger targets. This report documents some of the latest efforts by ARL in evaluating the use of modified shock tube exit jets for simulating non-ideal blast flow. Previous studies at ARL included the mapping of unspread exit jets at three different shock tube scaled sizes and the evaluation of exit jet spreaders at the two smaller shock tube sizes to evaluate the effectiveness of the various spreaders and determine the degree of uniformity of the spreading. In the latest effort, a full scale exit jet spreader has been constructed for use with the ARL 1.68-m diameter shock tube, the largest of the three shock tubes. Displacement experiments with World War 2 Army jeeps have been conducted to compare vehicle response to the dynamic pressure impulse loading generated by the spread jet of the shock tube with that from past actual and simulated nuclear tests in which jeep displacement data were obtained.

DTIC

*Shock Tubes; Nuclear Explosions; Aerial Explosions; Simulation*

**19980000959** MSE Technology Applications, Inc., Butte, MT USA

**Magnetohydrodynamics Accelerator Research into Advanced Hypersonics (MARIAH), Part 2 *Final Report, Apr. 1995 - Oct. 1997***

Baughman, Jack A., MSE Technology Applications, Inc., USA; Micheletti, David A., MSE Technology Applications, Inc., USA; Nelson, Gordon L., MSE Technology Applications, Inc., USA; Simmons, Gloyd A., MSE Technology Applications, Inc., USA; Oct. 1997; 436p; In English

Contract(s)/Grant(s): DE-AC22-96EW-96405; NASA Order A-45416-D

Report No.(s): NASA/CR-97-206242-Pt-2; NAS 1.26:206242-Pt-2; MSE-029-Pt-2; No Copyright; Avail: CASI; A19, Hardcopy; A04, Microfiche

This report documents the activities, results, conclusions and recommendations of the Magnetohydrodynamics Accelerator Research Into Advanced Hypersonics (MARIAH) Project in which the use of magnetohydrodynamics (MHD) technology is investigated for its applicability to augment hypersonic wind tunnels. The long range objective of this investigation is to advance the development of ground test facilities to support the development of hypervelocity flight vehicles. The MHD accelerator adds

kinetic energy directly to the wind tunnel working fluid, thereby increasing its Mach number to hypervelocity levels. Several techniques for MHD augmentation, as well as other physical characteristics of the process are studied to enhance the overall performance of hypersonic wind tunnel design. Specific recommendations are presented to improve the effectiveness of ground test facilities. The work contained herein builds on nearly four decades of research and experimentation by the aeronautics ground test and evaluation community, both foreign and domestic.

Author

*Magnetohydrodynamics; Hypersonic Wind Tunnels; Technology Utilization; Accelerators*

**19980001227** NERAC, Inc., Tolland, CT USA

**Simulators in Training. (Latest citations from the NTIS Bibliographic Database)**

Jun. 1997; In English; Page count unavailable. Supersedes PB96-863808

Report No.(s): PB97-860738; No Copyright; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning research on simulators and simulator technology in a broad range of training settings. Military settings are stressed. Aerial, ground, marine, and submarine operations are investigated. Simulators that allow students to perfect procedures are described, emphasizing training for firefighting, sonar, radar, spacecraft, and sea navigation. (Contains 50-250 citations and includes a subject term index and title list.)

NTIS

*Bibliographies; Training Simulators*

**19980001450**

**Deposition of airborne particles onto the human eye: wind tunnel studies of the deposition velocity onto the eyes of a mannequin**

Gudmundsson, A., Lund Inst. of Technology, Sweden; Schneider, T.; Bohgard, M.; Vinzents, P.; Akselsson, K. R.; Journal of Aerosol Science; September, 1997; ISSN 0021-8502; vol. Volume 28, no. no. 6, pp. 1085-1100; In English; Copyright; Avail: Issuing Activity

In the field of occupational hygiene much consideration is devoted to the uptake through the human airways, but there are also reports of irritations, complaints and hazards or potential hazards due to particle deposition onto the eyes. There is a need for data regarding the dependence of the deposition rate on particle size and environmental parameters in order to formulate sampling criteria and to find dose-response relations. The deposition of airborne particles onto the human eye was studied by making use of a dummy, the eyes of which were covered with pieces of transparent sticky foil. The dummy was exposed to airborne particles in a wind tunnel. The airborne particle concentration was simultaneously measured using an Aerodynamic Particle Sizer (APS, TSI Inc., U.S.A.). The deposited particles were counted using an optical microscope equipped with an image analyser. For the particle sizes (2-30 micron), wind velocities (0.5 and 1.0 ms(sup \$MIN 1), wind directions (0, 90 and 180 deg) and turbulence intensities (1.3 and 19%) employed in this study, deposition velocities onto the eyes were determined to be in the range of 0.001-1 cm s(sup -1).

Author (EI)

*Air Pollution; Eye (Anatomy); Wind Tunnels; Aerosols; Particulates; Deposition; Eye Protection; Hygiene; Industrial Safety*

**19980002115**

**Airport trains complete first phase of tests**

Railway Gazette International; August, 1997; ISSN 0373-5346; vol. Volume 153, no. no. 8, pp. 512; In English; Copyright; Avail: Issuing Activity

Ten weeks of trials with one of the first trains for Hong Kong MTR Corp's airport line culminated in a media presentation on July 2 at Adtranz works in Henningdorf near Berlin. The train had previously undergone static tests in Spain following assembly by CAF and was due to be shipped this month to Hong Kong for final trials and commissioning. According to project manager David Barry, the trials have not revealed any serious problems, although some work will be necessary to reduce noise levels. Noise is one of several demanding areas in MTR Corp's specification: safety, electromagnetic compatibility, ease of maintenance, reliability, and fire protection are others. Performance of individual components and whole trains is to be monitored and checked continuously during design and commissioning.

Author (revised by EI)

*Airports; Ground Support Equipment; Passengers; Transportation; Rail Transportation*



## 10 ASTRONAUTICS

*Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.*

**19980001216** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**FESTIP Aerothermodynamics: Experimental Investigation of Base Flow and Exhaust Plume Interaction**

Bannink, W. J., Technische Univ., Netherlands; Bakker, P. G., Technische Univ., Netherlands; Houtman, E. M., Technische Univ., Netherlands; Mar. 1997; 28p; In English

Report No.(s): PB97-182968; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Afterbody and base pressure measurements and flow visualization results are presented for a blunted cone-cylinder model rocket which had a centrally protruding nozzle. The model was mounted in supersonic free streams of Mach 2 and 3 produced by the Delft University transonic/supersonic wind tunnel. The jet exhausting from the nozzle had an exit Mach number of 4 and operated at various jet stagnation pressures, such as to have different jet exit pressure to ambient flow pressures ratios. These ratios all exceeded unity indicating that one had to do with underexpanded jet flow. The present investigation was part of a joint computational/experimental research program on base flow-jet plume interactions. The experimental results serve as data for Navier-Stokes code validation testing compressible turbulence models.

NTIS

*Aerothermodynamics; Supersonic Flow; Navier-Stokes Equation; Jet Flow; Gas Streams; Free Flow; Flow Visualization; Flow Characteristics; Base Flow*

## 11 CHEMISTRY AND MATERIALS

*Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.*

**19980000333** Virginia Univ., School of Engineering and Applied Science, Charlottesville, VA USA

**NASA-UVA Light Aerospace Alloy and Structures Technology Program (LA2ST), Research on Materials for the High Speed Civil Transport Progress Report, 1 Jan. - 30 Jun. 1997**

Gangloff, Richard P., Virginia Univ., USA; Starke, Edgar A., Jr., Virginia Univ., USA; Kelly, Robert G., Virginia Univ., USA; Scully, John R., Virginia Univ., USA; Stoner, Glenn E., Virginia Univ., USA; Wert, John A., Virginia Univ., USA; Jul. 1997; 100p; In English

Contract(s)/Grant(s): NAG1-745

Report No.(s): NASA-CR-205216; NAS 1.26:205216; UVA/528266/MSE97/124; No Copyright; Avail: CASI; A05, Hardcopy; A02, Microfiche

Since 1986, the NASA-Langley Research Center has sponsored the NASA-UVA Light Alloy and Structures Technology (LA2ST) Program at the University of Virginia (UVA). The fundamental objective of the LA2ST program is to conduct interdisciplinary graduate student research on the performance of next generation, light-weight aerospace alloys, composites and thermal gradient structures. The LA2ST program has aimed to product relevant data and basic understanding of material mechanical response, environmental/corrosion behavior, and microstructure; new monolithic and composite alloys; advanced processing methods; measurement and modeling advances; and a pool of educated graduate students for aerospace technologies. The scope of the LA2ST Program is broad. Research areas include: (1) Mechanical and Environmental Degradation Mechanisms in Advanced Light Metals and Composites, (2) Aerospace Materials Science, (3) Mechanics of materials for Aerospace Structures,

and (4) Thermal Gradient Structures. A substantial series of semi-annual progress reports issued since 1987 documents the technical objectives, experimental or analytical procedures, and detailed results of graduate student research in these topical areas.

Derived from text

*Composite Structures; Spacecraft Construction Materials; Structural Engineering; Supersonic Transports; Temperature Gradients; Light Alloys; Mechanical Properties; Microstructure; Degradation; Corrosion; Composite Materials; Aircraft Structures; Aircraft Construction Materials*

**19980000988** Electricite de France, Clamart, France

**Experimental and numerical study of a premixed flame stabilized by a rectangular section cylinder**

Bailly, P., Electricite de France, France; Garreton, D., Electricite de France, France; Bruel, P., Ecole Nationale Supérieure de Mécanique et d'Aérotechnique, France; Champion, M., Ecole Nationale Supérieure de Mécanique et d'Aérotechnique, France; 1996; 18p; In English

Report No.(s): EDF-96-NB-00133; DE97-732652; No Copyright; Avail: Issuing Activity (Nat'l Technical Information Service (NTIS)); US Sales Only, Microfiche

A numerical and experimental study of a turbulent reactive zone stabilized by a rectangular cross-section cylinder positioned in a fully developed turbulent channel flow of a propane-air mixture is presented. Such a flow geometry has been chosen because it features most of the phenomena (recirculation zones, flame stabilization, wall-flame interactions) present in systems of practical interest. The flow is experimentally investigated with a 2-D laser Doppler velocimeter and thin compensated thermocouples. The modelling of the reactive flow is based on a modified Bray-Moss-Libby combustion model associated with a Reynolds-Stress turbulence model. The resulting set of equations is solved by a finite difference Navier-Stokes code on a rectilinear mesh. The comparison between numerical and experimental results shows that the use of a full second-order model with dedicated equations for both the Reynolds stresses and the scalar turbulent flux does not lead to a significant improvement of the numerical results. Indeed, although the longitudinal scalar turbulent flux exhibits a non-gradient behaviour, the evolution of the mean progress variable introduced by the Bray-Moss-Libby model appears to be mainly controlled by the transverse scalar gradient which follows in all cases a gradient like behaviour. Additional measurements and calculations are required to precise the exact range of mass flow rate, equivalence ratio and obstacle bluntness over which such a tendency can be observed. Nevertheless, the tentative conclusion of this study is that, as soon as a refinement of the modelling of reactive flows in combustors which involve flameholders similar to the one investigated in this study is needed, the use of a Reynolds-Stress model should be the first necessary step. Then, depending on the exact nature of the flow geometry, a second phase should consist in evaluating the need for the use of a full second order model like the one presented in this study.

DOE

*Flame Propagation; Gas Turbine Engines; Thermocouples; Laser Doppler Velocimeters; Navier-Stokes Equation; Turbulent Flow; Stress Analysis; Premixed Flames; Channel Flow; Chemical Reactions*

**19980001221** Naval Air Warfare Center, Air Vehicle and Crew Systems Technology Dept., Warminster, PA USA

**Aircraft Materials for Corrosion Prevention and Control: A Qualified Products List *Final Report***

DeLuccia, John J., Naval Air Warfare Center, USA; Sep. 1993; 58p; In English

Contract(s)/Grant(s): DTFA03-90-A-00029

Report No.(s): AD-A325769; NAWCADWAR-94099-60; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This is a product list of materials for corrosion prevention and control that have been tested and are known to perform to the strict requirements of the military. This report was produced for the Federal Aviation Administration to be incorporated into their Advisory Circular on Corrosion Control for Aircraft, AC-43-4A, as chapter 8. Although written for civil aviation, the product information contained herein is valuable to all aircraft maintenance communities-both military and civilian. The products are grouped under the generic classes of materials: cleaners; sealants; and corrosion preventive compounds. Brief descriptions of the product classes relating to their function for corrosion prevention and/or control are given. Product lists, appropriately grouped, are given along with manufacturer's names and addresses.

DTIC

*Alternating Current; Civil Aviation; Corrosion Prevention; Aircraft Maintenance; Cleaners; Corrosion*



## 12 ENGINEERING

*Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.*

**19980000061** Pennsylvania State Univ., Applied Research Lab., University Park, PA USA

**Development of a Low-Reynolds Number, Nonlinear kappa-epsilon Model for the Reduced Navier-Stokes Equations**  
**Final Report**

Boger, David A., Pennsylvania State Univ., USA; Govindan, T. R., Pennsylvania State Univ., USA; McDonald, Henry, Pennsylvania State Univ., USA; [1997]; 18p; In English

Contract(s)/Grant(s): NAG3-1781

Report No.(s): NASA/CR-97-206334; NAS 1.26:206334; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Previous work at NASA LeRC has shown that flow distortions in aircraft engine inlet ducts can be significantly reduced by mounting vortex generators, or small wing sections, on the inside surface of the engine inlet. The placement of the vortex generators is an important factor in obtaining the optimal effect over a wide operating envelope. In this regard, the only alternative to a long and expensive test program which would search out this optimal configuration is a good prediction procedure which could narrow the field of search. Such a procedure has been developed in collaboration with NASA LeRC, and results obtained by NASA personnel indicate that it shows considerable promise for predicting the viscous turbulent flow in engine inlet ducts in the presence of vortex generators. The prediction tool is a computer code which numerically solves the reduced Navier-Stokes equations and so is commonly referred to as RNS3D. Obvious deficiencies in RNS3D have been addressed in previous work. Primarily, it is known that the predictions of the mean velocity field of a turbulent boundary layer flow approaching separation are not in good agreement with data. It was suggested that the use of an algebraic mixing-length turbulence model in RNS3D is at least partly to blame for this. Additionally, the current turbulence model includes an assumption of isotropy which will ultimately fail to capture turbulence-driven secondary flow known to exist in noncircular ducts.

Derived from text

*Navier-Stokes Equation; Low Reynolds Number; Vortex Generators; Viscous Flow; Turbulent Flow; K-Epsilon Turbulence Model; Engine Inlets; Predictions; Aircraft Engines; Boundary Layer Separation*

**19980000078** Vehicle Technology, San Jose, CA USA

**Outboard Waterjet Propulsion Development** *Monthly Report No. 3, 1-31 Aug. 1997*

Rodler, Waldo E., Vehicle Technology, USA; Aug. 31, 1997; 14p; In English

Contract(s)/Grant(s): USZA22-97-P-0041

Report No.(s): AD-A329215; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The project is currently on schedule. The design review meeting was held on 08/26/97 at the Coastal Systems Station in Panama City, Florida. The mechanical arrangement, performance analysis and design features were presented at the review meeting. A number of suggestions and recommendations from the participants were noted for future guidance of the project. A meeting on 27 August was held at the 2CI facility to plan the continuing engineering and design efforts by 2CI and Vehicle Technology. Some of the significant data presented is attached herewith: Attachment A: NBOE Specification Comparison. This list shows that the proposed outboard waterjet should be able to meet the specification. Attachment B: This diagram shows the general arrangement, with engine cover removed, of the outboard waterjet. Attachment C: This diagram provides the major dimensions of the current design layout. Attachment D: This shows the arrangement of the mainshaft assembly with impeller and pulley. This assembly is driven from the engine by means of a HTD toothed belt. Attachment E: This shows the weight analysis. Jet weights were mainly proportioned from actual scale weights of a similar, but larger, jet. The engine weight was an actual scale weight of the current version of the engine. Attachment F: This shows the estimated resistance curve for the hull based on tests of a similar size hull (no test data was available for the current hull). Thrust curves for the jet are given for 55 horsepower (the power necessary for this application) and at 70 horsepower, the normal rating of this engine. Production dynamometer results for this engine average about 73 horsepower.

DTIC

*Jet Propulsion; Turbojet Engines; Hydraulic Jets; Product Development*

**19980000199** Pennsylvania State Univ., Center for Gas Turbine and Power, University Park, PA USA

**Unsteady Flow Field in a Multistage Axial Flow Compressor Final Report**

Suryavamshi, N., Pennsylvania State Univ., USA; Lakshminarayana, B., Pennsylvania State Univ., USA; Prato, J., Pennsylvania State Univ., USA; Jan. 1997; 322p; In English

Contract(s)/Grant(s): NAG3-1222; NAG3-1745

Report No.(s): NASA/CR-97-206511; NAS 1.26:206511; PSU-CGTP-9701; No Copyright; Avail: CASI; A14, Hardcopy; A03, Microfiche

The flow field in a multistage compressor is three-dimensional, unsteady, and turbulent with substantial viscous effects. Some of the specific phenomena that has eluded designers include the effects of rotor-stator and rotor-rotor interactions and the physics of mixing of velocity, pressure, temperature and velocity fields. An attempt was made, to resolve experimentally, the unsteady pressure and temperature fields downstream of the second stator of a multistage axial flow compressor which will provide information on rotor-stator interaction effects and the nature of the unsteadiness in an embedded stator of a three stage axial flow compressor. Detailed area traverse measurements using pneumatic five hole probe, thermocouple probe, semi-conductor total pressure probe (Kulite) and an aspirating probe downstream of the second stator were conducted at the peak efficiency operating condition. The unsteady data was then reduced through an ensemble averaging technique which splits the signal into deterministic and unresolved components. Auto and cross correlation techniques were used to correlate the deterministic total temperature and velocity components (acquired using a slanted hot-film probe at the same measurement locations) and the gradients, distributions and relative weights of each of the terms of the average passage equation were then determined. Based on these measurements it was observed that the stator wakes, hub leakage flow region, casing endwall suction surface corner region, and the casing endwall region away from the blade surfaces were the regions of highest losses in total pressure, lowest efficiency and highest levels of unresolved unsteadiness. The deterministic unsteadiness was found to be high in the hub and casing endwall regions as well as on the pressure side of the stator wake. The spectral distribution of hot-wire and kulite voltages shows that at least eight harmonics of all three rotor blade passing frequencies are present at this measurement location. In addition to the basic three rotor blade passing frequencies (R1, R2 and R3) and their harmonics, various difference frequencies such as (2R1 -R2) and (2R3-R2) and their harmonics are also observed. These difference frequencies are due to viscous and potential interactions between rotors 1, 2 and 3 which are sensed by both the total pressure and aspirating probes at this location. Significant changes occur to the stator exit flow features with passage of the rotor upstream of the stator. Because of higher convection speeds of the rotor wake on the suction surface of the downstream stator than on the pressure side, the chopped rotor wake was found to be arriving at different times on either side of the stator wake. As the rotor passes across the stator.

Author

*Unsteady Flow; Centrifugal Compressors; Flow Distribution*

**19980000392** Iowa State Univ. of Science and Technology, Ames, IA USA

**Comparison of CFC-114 and HFC-236ea Performance in Shipboard Vapor Compression Systems Final Report, Oct. 1992 - May 1995**

Ray, D. T., Iowa State Univ. of Science and Technology, USA; Pate, M. B., Iowa State Univ. of Science and Technology, USA; Shapiro, H. N., Iowa State Univ. of Science and Technology, USA; Jun. 1997; 88p; In English, USA

Report No.(s): PB97-178735; No Copyright; Avail: Issuing Activity (Nat'l Technical Information Service (NTIS)), Microfiche

The report gives results of a comparison of the performance of two refrigerants-1,1, 1,2,3,3-hexafluoropropane (HFC-236ea) and 1,2-dichloro-tetrafluoro-ethane (CFC-114)--in shipboard vapor compression refrigeration systems. A computer model was developed for comparing the two refrigerants in a simulated 440-kW centrifugal chillersystem. Equations for modeling each system component were developed and solved using the Newton-Raphson method for multiple equations and unknowns. Correlations were developed for CFC-114 and HFC-236ea boiling and condensing coefficients taken at the Iowa State Heat Transfer Test Facility. The experimental data provided by the NSWCC sufficiently validate the model, and the simulation model predicts that HFC-236ea would perform favorably as a drop-in substitute for CFC-114. Several recommendations are discussed which may further improve the performance of HFC-236ea in Navy chillers.

NTIS

*Refrigerants; Centrifugal Compressors; Ships; Evaluation; Environmental Chemistry; Condensing*

**19980000408** NASA Langley Research Center, Hampton, VA USA

**Measured Changes in C-Band Radar Reflectivity of Clear Air Caused by Aircraft Wake Vortices**

Mackenzie, Anne I., NASA Langley Research Center, USA; Nov. 1997; 82p; In English

Contract(s)/Grant(s): RTOP 548-10-41-01

Report No.(s): NASA-TP-3671; NAS 1.60:3671; L-17618; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

Wake vortices from a C-130 airplane were observed at the NASA Wallops Flight Facility with a ground-based, monostatic C-band radar and an antenna-mounted boresight video camera. The airplane wake was viewed from a distance of approximately 1 km, and radar scanning was adjusted to cross a pair of marker smoke trails generated by the C-130. For each airplane pass, changes in radar reflectivity were calculated by subtracting the signal magnitudes during an initial clutter scan from the signal magnitudes during vortex-plus-clutter scans. The results showed both increases and decreases in reflectivity on and near the smoke trails in a characteristic sinusoidal pattern of heightened reflectivity in the center and lessened reflectivity at the sides. Reflectivity changes in either direction varied from -131 to -102 dBm(exp -1); the vortex-plus-clutter to noise ratio varied from 20 to 41 dB. The radar recordings lasted 2.5 min each; evidence of wake vortices was found for up to 2 min after the passage of the airplane. Ground and aircraft clutter were eliminated as possible sources of the disturbance by noting the occurrence of vortex signatures at different positions relative to the ground and the airplane. This work supports the feasibility of vortex detection by radar, and it is recommended that future radar vortex detection be done with Doppler systems.

Author

*Aircraft Wakes; Radar Detection; Vortices; Microwave Frequencies*

**19980000417** NASA Lewis Research Center, Cleveland, OH USA

**Demonstration of PIV in a Transonic Compressor**

Wernet, Mark P., NASA Lewis Research Center, USA; Oct. 1997; 16p; In English; 90th; Symposium on Nonintrusive Measurement Techniques for Propulsion Engines, 20-24 Oct. 1997, Brussels, Belgium; Sponsored by Advisory Group for Aerospace Research and Development, France; Original contains color illustrations

Contract(s)/Grant(s): RTOP 519-20-53-00

Report No.(s): NASA-TM-113164; NAS 1.15:113164; E-10921; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Particle Imaging Velocimetry (PIV) is a powerful measurement technique which can be used as an alternative or complementary approach to Laser Doppler Velocimetry (LDV) in a wide range of research applications. PIV data are measured simultaneously at multiple points in space, which enables the investigation of the non-stationary spatial structures typically encountered in turbomachinery. Many of the same issues encountered in the application of LDV techniques to rotating machinery apply in the application of PIV. Preliminary results from the successful application of the standard 2-D PIV technique to a transonic axial compressor are presented. The lessons learned from the application of the 2-D PIV technique will serve as the basis for applying 3-component PIV techniques to turbomachinery.

Author

*Transonic Compressors; Particle Image Velocimetry; Turbocompressors*

**19980000443** NERAC, Inc., Tolland, CT USA

**Aircraft Antennas. (Latest citations from the INSPEC Database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-851142

Report No.(s): PB97-852420; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the design and applications of aircraft antennas in communications, navigation, radar, and landing systems. The citations explore radiation pattern calculations and measurements, antenna couplings, jamming problems, conformal arrays, microstrip antennas, and phased array aircraft antennas.

NTIS

*Bibliographies; Aircraft Antennas; Design Analysis; Antenna Couplers*

**19980000462** NERAC, Inc., Tolland, CT USA

**Gas Turbines: Protective Coatings for Corrosion and Erosion Protection. (Latest citations from METADEX)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-851886

Report No.(s): PB97-852594; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning protective coatings for gas turbines to minimize corrosion and erosion problems. Citations examine erosion of turbine blades resulting from the presence of fly ash and finely divided particles in the environment, and discuss the use of ceramic coatings for erosion protection. The formation of molten sodium sulfide on turbine blades and resulting hot corrosion are also discussed. (Contains 50-250 citations and includes a subject term index and title list.)

NTIS

*Bibliographies; Protective Coatings; Gas Turbine Engines; Turbine Blades; Corrosion Resistance; Erosion*

**19980000642** Technische Univ., Delft, Netherlands

**Calculation of Unsteady Attached Cavitation**

Janssens, M. E., Technische Univ., Netherlands; Dec. 1996; 105p; In English

Report No.(s): PB97-182976; Memo-M-753; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

In this report, a numerical method is investigated to simulate unsteady cavitation on airfoils. In this technique, the flow of a hypothetical mixture, part liquid, part vapor is calculated. In this flow, the relation between density and pressure is determined by the equation of state. The equation of state has been chosen to give an approximation of the actual physics present in cavitation. It specifies that the density equals the liquid density in non-cavitating regions of the flow and equals the vapor density in cavitating regions. The major part of the flow domain will be non-cavitating and have constant density. In this part of the flow field a special solution technique, artificial compressibility, is needed to calculate the flow. In this report, it is shown that this technique can be extended to allow calculation of the flow in regions with non-constant density (as will occur in cavitating regions). The technique has been implemented in a computer program which can simulate the flow around a two-dimensional airfoil. It will be shown that the program can reliably simulate incompressible (steady and unsteady) flow and the initial growth phase of attached sheet cavitation.

NTIS

*Cavitation Flow; Airfoils; Numerical Analysis; Unsteady Flow; Incompressible Flow; Flow Distribution*

**19980001155** NERAC, Inc., Tolland, CT USA

**Planetary Gears. (Latest Citations from the Ei Compendex\*Plus Database)**

Jan. 1997; In English; Page count unavailable

Report No.(s): PB97-854053; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning planetary gear design, analysis, and application. Topics include stress analysis, vibration, efficiency, optimization, and mathematical techniques. Automotive and helicopter applications are included.

NTIS

*Stress Analysis; Design Analysis; Helicopters; Automobiles; Data Bases; Vibration*

**19980001262** Technische Univ., Faculty of Aerospace Engineering, Delft, Netherlands

**Review of Local Inclination Methods in Hypersonics and Applications**

Walpot, L. M. G., Technische Univ., Netherlands; Bannink, W. J., Technische Univ., Netherlands; Bakker, P. G., Technische Univ., Netherlands; Dec. 1996; 32p; In English

Report No.(s): PB97-190102; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report contains several of the most common local inclination methods used in hypersonics. Local inclination methods are based on the assumption that the local pressure is only a function of the free stream Mach number and the inclination of the local surface to the free stream direction. These methods are mainly used to design and estimate the aerodynamic characteristics on a vehicle flying at hypersonic speed. To illustrate these methods, some calculations are done on a bent and flat biconic generic form. In Europe, a new program MSTP (Manned Space Transportation Program) is launched for a bent biconic shape, as a follow up of the cancelled HERMES program. The computational results are compared with Euler computations (finite elements and finite volumes) and with experimental data.

NTIS

*Supersonic Flow; Hypersonic Aircraft; Reentry Vehicles; Flow Equations; Aerodynamic Characteristics; Prandtl-Meyer Expansion*

**19980001264** Technische Univ., Delft, Netherlands

**Evaluation and Extension of a Grid Adaptation Algorithm in a 2D Flow Simulation Code**

Poortman, A. K., Technische Univ., Netherlands; Dec. 1996; 84p; In English

Report No.(s): PB97-183057; Memo-M-750; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report describes the evaluation and extension of an existing flow simulation method developed at NLR. In this method, called HI-TASK (Highly Integrated Turbulent Airfoil-flow Simulation Kernel), a grid adaptation algorithm is coupled with a 2D flow solver for the Reynolds-averaged Navier-Stokes (RaNS) equations. In HI-TASK, a flow solution is calculated on a conventional single-block structured grid, the so-called initial grid. Subsequently, the grid is adapted to the flow solution obtained on the initial grid, resulting in small grid cells where the initial flow solution gradients are high and large cells in regions of small variation. The adaptation is carried out by moving the grid lines, i.e. the number of grid nodes is fixed. Subsequently, the flow solution is obtained on the adapted grid. In this way a flow solution is obtained of an accuracy comparable with the accuracy of a flow



solution computed on a grid with much more grid points. The single grid adaptation of HI-TASK has been evaluated and it has been found that the solution on the adapted grid is improved substantially compared to the solution on the initial grid. Computational results are presented and compared with experimental data for the RAE2822 and NLR8602 airfoils under transonic flow conditions.

NTIS

*Structured Grids (Mathematics); Airfoils; Turbulent Flow; Computational Grids; Transonic Flow; Reynolds Number; Grid Generation (Mathematics); Navier-Stokes Equation*

**19980001624**

**Three-dimensional shock loss model applied to an aft-swept, transonic compressor rotor**

Puterbaugh, S. L., Wright Lab., USA; Copenhaver, W. W.; Hah, C.; Wennerstrom, A. J.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 452-459; In English; Copyright; Avail: Issuing Activity

An analysis of the effectiveness of a three-dimensional shock loss model used in transonic compressor rotor design is presented. The model was used during the design of an aft-swept, transonic compressor rotor. The demonstrated performance of the swept rotor, in combination with numerical results, is used to determine the strengths and weaknesses of the model. The numerical results were obtained from a fully three-dimensional Navier-Stokes solver. The shock loss model was developed to account for the benefit gained with three-dimensional shock sweep. Comparisons with the experimental and numerical results demonstrated that shock loss reductions predicted by the model due to the swept shock induced by the swept leading edge of the rotor were exceeded. However, near the tip the loss model underpredicts the loss because the shock geometry assumed by the model remains swept in this region while the numerical results show a more normal shock orientation. The design methods and the demonstrated performance of the swept rotor are also presented. Comparisons are made between the design intent and measured performance parameters. The aft-swept rotor was designed using an inviscid axisymmetric streamline curvature design system utilizing arbitrary airfoil blading geometry. The design goal specific flow rate was 214.7 kg/s/m(sup 2) (43.98 lbm/sec/ft(sup 2)), the design pressure ratio goal was 2.042, and the predicted design point efficiency was 94.0. The rotor tip speed was 457.2 m/s (1500 ft/sec). The design flow rate was achieved while the pressure ratio fell short by 0.07. Efficiency was 3 points below prediction, though at a very high 91 percent. At this operating condition the stall margin was 11 percent.

Author (EI)

*Compressor Rotors; Sweptback Wings; Three Dimensional Models; Transonic Compressors; Compressors; Rotors; Mathematical Models; Transonic Flow*

**19980001625**

**Boundary layer development in axial compressors and turbines: Part 2 of 4 - Compressors**

Halstead, D. E., GE Aircraft Engines, USA; Wisler, D. C.; Okiishi, T. H.; Walker, G. J.; Hodson, H. P.; Shin, H. -W.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 426-444; In English; Copyright; Avail: Issuing Activity

This is Part Two of a four-part paper. It begins with Section 6.0 and continues to describe the comprehensive experiments and computational analyses that have led to a detailed picture of boundary layer development on airfoil surfaces in multistage turbomachinery. In this part, we present the experimental evidence used to construct the composite picture for compressors given in the discussion in Section 5.0 of Part 1. We show the data from the surface hot-film gages and the boundary layer surveys, give a thorough interpretation for the baseline operating condition, and then show how this picture changes with variations in Reynolds number, airfoil loading, frequency of occurrence of wakes and wake turbulence intensity. Detailed flow features are described using raw time traces. The use of rods to simulate airfoil wakes is also evaluated.

Author (EI)

*Boundary Layers; Compressors; Computer Techniques; Diagnosis; Axial Flow; Turbomachinery; Reynolds Number*

**19980001634**

**Effect of modification to tongue and impeller geometry on unsteady flow, pressure fluctuations, and noise in a centrifugal pump**

Dong, R., The Johns Hopkins Univ., USA; Chu, S.; Katz, J.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 506-515; In English; Copyright; Avail: Issuing Activity

Particle Image Velocimetry (PIV), pressure, and noise measurements are used to study the effect of modifications to tongue and impeller geometries on the flow structure and resulting noise in a centrifugal pump. It is demonstrated that the primary sources of noise are associated with interactions of the nonuniform outflow from the impeller (jet/wake phenomenon) with the tongue.

Consequently, significant reduction of noise is achieved by increasing the gap between the tongue and the impeller up to about 20 percent of the impeller radius. Further increase in the gap affects the performance adversely with minimal impact on the noise level. When the gap is narrow, the primary sources of noise are impingement of the wake on the tip of the tongue, and tongue oscillations when the pressure difference across it is high. At about 20 percent gap, the entire wake and its associated vorticity trains miss the tongue, and the only (quite weak) effect of nonuniform outflux is the impingement of the jet on the tongue. An attempt is also made to reduce the nonuniformity in outflux from the impeller by inserting short vanes between the blades. They cause reduction in the size of the original wakes, but generate an additional jet/wake phenomenon of their own. Both wakes are weak to a level that their impacts on local pressure fluctuations and noise are insignificant. The only remaining major contributor to noise is tongue oscillations. This effect is shown to be dependent on the stiffness of the tongue.

Author (EI)

*Centrifugal Pumps; Pressure Oscillations; Unsteady Flow; Rotors; Pressure Measurement*

**19980001635**

**Development of a high-specific-speed centrifugal compressor**

Rodgers, C., 3010 N Arroyo Drive, USA; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 501-505; In English; Copyright; Avail: Issuing Activity

This paper describes the development of a subscale single-stage centrifugal compressor with a dimensionless specific speed (Ns) of 1.8, originally designed for full-size application as a high volume flow, low pressure ratio, gas booster compressor. The specific stage is noteworthy in that it provides a benchmark representing the performance potential of very high-specific-speed compressors, of which limited information is found in the open literature. Stage and component test performance characteristics are presented together with traverse results at the impeller exit. Traverse test results were compared with recent CFD computational predictions for an exploratory analytical calibration of a very high-specific-speed impeller geometry. The tested subscale (0.583) compressor essentially satisfied design performance expectations with an overall stage efficiency of 74 percent including, excessive exit casing losses. It was estimated that stage efficiency could be increased to 81 percent with exit casing losses halved.

Author (EI)

*Centrifugal Compressors; High Speed; Compressors; Centrifuges; Rotors*

**19980001637**

**Navier-Stokes and potential calculations of axial spacing effect on vortical and potential disturbances and gust response in an axial compressor**

Chung, M. -H., Natl. Taiwan Univ., Taiwan, Province of China; Wo, A. M.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 472-481; In English; Copyright; Avail: Issuing Activity

The effect of blade row axial spacing on vortical and potential disturbances and gust response is studied for a compressor stator/rotor configuration near design and at high loadings using two-dimensional incompressible Navier-Stokes and potential codes, both written for multistage calculations. First, vortical and potential disturbances downstream of the isolated stator in the moving frame are defined; these disturbances exclude blade row interaction effects. Then, vortical and potential disturbances for the stator/rotor configuration are calculated for axial gaps of 10, 20, and 30 percent chord. Results show that the potential disturbance is uncoupled locally; the potential disturbance calculated from the isolated stator configuration is a good approximation for that from the stator/rotor configuration upstream of the rotor leading edge at the locations studied. The vortical disturbance depends strongly on blade row interactions. Low-order modes of vortical disturbance are of substantial magnitude and decay much more slowly downstream than do those of potential disturbance. Vortical disturbance decays linearly with increasing mode except very close to the stator trailing edge. For a small axial gap, e.g., 10 percent chord, both vortical and potential disturbances must be included to determine the rotor gust response.

Author (EI)

*Dynamic Response; Navier-Stokes Equation; Compressors; Axial Flow; Turbomachinery; Turbomachine Blades*

**19980002015**

**Evaluation of flow field approximations for transonic compressor stages**

Domey, D. J., Western Michigan Univ., USA; Sharma, O. P.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 445-451; In English; Copyright; Avail: Issuing Activity

The flow through gas turbine compressors is often characterized by unsteady, transonic, and viscous phenomena. Accurately predicting the behavior of these complex multi-blade-row flows with unsteady rotor-stator interacting Navier-Stokes analyses can require enormous computer resources. In this investigation, several methods for predicting the flow field, losses, and performance quantities associated with axial compressor stages are presented. The methods studied include: (1) the unsteady fully coupled



blade row technique, (2) the steady coupled blade row method, (3) the steady single blade row technique, and (4) the loosely coupled blade row method. The analyses have been evaluated in terms of accuracy and efficiency.

Author (EI)

*Flow Distribution; Transonic Compressors; Compressors; Transonic Flow; Evaluation; Approximation; Viscous Flow*

**19980002016**

**Stall precursor identification in high-speed compressor stages using chaotic time series analysis methods**

Bright, M. M., NASA Lewis Research Center, USA; Qammar, H. K.; Weigl, H. J.; Paduano, J. D.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 491-499; In English; Copyright; Avail: Issuing Activity

This paper presents a new technique for precursor identification in high-speed compressors. The technique is a pseudo-correlation integral method referred to as the correlation method. To provide a basis for comparison, the travelling wave energy technique, which has been used extensively to study prestall data, is also briefly presented and applied. The correlation method has a potential advantage over the traveling wave energy method because it uses a single sensor for detection. It also requires no predisposition about the expected behavior of the data to detect 'changes' in the behavior of the compressor. Both methods are used in this study to identify stall precursive events in the pressure fluctuations measured from circumferential pressure transducers located at the front face of the compressor rig. The correlation method successfully identified stall formation or changes in the compressor dynamics from data captured from four different configurations of a NASA Lewis single-stage high-speed compressor while it was transitioned from stable operation into stall. This paper includes an exposition on the use of nonlinear methods to identify stall precursors, a description of the methodologies used for the study, information on the NASA high-speed compressor rig and experimental data acquisition, and results from the four compressor configurations. The experimental results indicate that the correlation method provides ample warning of the onset of rotating stall at high speed, in some tests on the order of 2000 rotor revolutions. Complementary features of the correlation method and the traveling wave energy method are discussed, and suggestions for future developments are made.

Author (EI)

*High Speed; Time Series Analysis; Compressors; Chaos; Correlation; Pressure Measurement*

**19980002074**

**Experimental investigation of steady and unsteady flow field downstream of an automotive torque converter turbine and inside the stator: Part II - Unsteady pressure on the stator blade surface**

Marathe, B. V., The Pennsylvania State Univ., USA; Lakshminarayana, B.; Maddock, D. G.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 634-645; In English; Copyright; Avail: Issuing Activity

The stator flow field of an automotive torque converter is highly unsteady due to potential and viscous interactions with upstream and downstream rotors. The objective of this investigation is to understand the influence of potential and viscous interactions of the upstream rotor on the stator surface pressure field with a view toward improvement of the stator design. Five miniature fast-response pressure transducers were embedded on the stator blade. The measurements were conducted at three locations near the leading edge and two locations near the trailing edge at the midspan location. The upstream flow field was measured using a fast response five-hole probe and is described in Part I of this paper. The experimental data were processed in the frequency domain by spectrum analysis and in the temporal-spatial domain by the ensemble-averaging technique. The flow properties were resolved into mean, periodic, aperiodic, and unresolved components. The unsteady amplitudes agreed well with the pressure envelope predicted by panel methods. The aperiodic component was found to be significant due to the rotor-rotor and rotor-stator interactions observed in multistage, multispool environment.

Author (EI)

*Flow Distribution; Stator Blades; Steady Flow; Torque Converters; Unsteady Flow; Turbines; Rotors; Stators*

**19980002189**

**Analysis of hot streak effects on turbine rotor heat load**

Shang, T., Pratt & Whitney, USA; Epstein, A. H.; Journal of Turbomachinery, Transactions of the ASME; July, 1997; ISSN 0889-504X; vol. Volume 119, no. no. 3, pp. 544-553; In English; Copyright; Avail: Issuing Activity

The influence of inlet hot streak temperature distortion on turbine blade heat load was explored on a transonic axial flow turbine stage test article using a three-dimensional, multiblade row unsteady Euler code. The turbine geometry was the same as that used for a recently reported testing of hot streak influence. Emphasis was placed on elucidating the physical mechanisms by which hot streaks affect turbine durability. It was found that temperature distortion significantly increases both blade surface heat load

nonuniformity and total blade heat load by as much as 10-30 percent (mainly on the pressure surface), and that the severity of this influence is a strong function of turbine geometry and flow conditions. Three physical mechanisms were identified that drive the heat load nonuniformity: buoyancy, wake convection (the Kerrebrock-Mikolajczak effect), and rotor-stator interactions. The latter can generate significant nonuniformity of the time-averaged relative frame rotor inlet temperature distribution. Dependence of these effects on turbine design variables was investigated to shed light on the design space, which minimizes the adverse effects of hot streaks.

Author (EI)

*Loads (Forces); Turbines; Rotors; High Temperature; Temperature Effects; Turbomachine Blades; Axial Flow; Turbomachinery*

**19980002319**

**Inertial collection of fine particles using a high-volume rectangular geometry conventional impactor**

Sioutas, C., Harvard Univ., USA; Ferguson, S. T.; Wolfson, J. M.; Ozkaynak, H.; Koutrakis, P.; Journal of Aerosol Science; September, 1997; ISSN 0021-8502; vol. Volume 28, no. no. 6, pp. 1015-1028; In English; Copyright; Avail: Issuing Activity

This paper presents the development and evaluation of a high-volume rectangular geometry conventional impactor. Operating with a preselective inlet that removes particles larger than 2.5 micron in aerodynamic size, the impactor has been designed to sample ambient fine particles in the accumulation mode range ( $0.1 < d_{p, aerodynamic} < 2.5$  micron). Particles are accelerated in a rectangular nozzle, 0.032 cm wide and 28 cm long, and impact on a filter medium attached on a porous ss frit, which is soaked in mineral oil. The impactor operates at a flow rate of 1000 l min<sup>-1</sup> with a total pressure drop of 30 kPa. The performance of the slit-nozzle impactor was validated in laboratory and field tests. Laboratory experiments conducted with monodisperse fluorescent PSL particles showed that the aerodynamic diameter of the 50% outpoint of the impactor is approximately 0.09 micron. Laboratory and field intercomparisons between the high-volume slit impactor and the microorifice uniform deposit impactor (MOUDI) showed that particulate nitrate and sulfate concentrations obtained with the two samplers are in good agreement (within 10%). Finally, a comparison between the particulate nitrate concentrations obtained with high-volume impactor and the Harvard/EPA annular denuder system (HEADS) was conducted, using indoor air as the test aerosol. Results from this comparison indicated that losses of nitrate from the impactor are not substantial and range between 5 and 15%. Results from the laboratory and field tests suggest that the high-volume impactor presented in this study constitutes a major improvement in the field of high-volume fine particle sampling.

Author (EI)

*Particulates; Fluid Flow; Aerodynamics; Fluid Filters*

## 13 GEOSCIENCES

*Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.*

**19980000486** NERAC, Inc., Tolland, CT USA

**Bioremediation. (Latest citations from the NTIS Bibliographic Database)**

Dec. 1996; In English; Page count unavailable. Supersedes PB96-850979

Report No.(s): PB97-852412; Copyright Waived; Avail: Issuing Activity (Natl Technical Information Service (NTIS)), Microfiche

The bibliography contains citations concerning the decomposition of toxic materials by biological means. Bacterial decomposition of jet fuel, wood preservatives, explosives, crude oil, halogenated organics, diesel fuel, aviation fuel, and creosote is discussed. Enhancement of decomposition rates by addition of nutrients is also included.

NTIS

*Bibliographies; Hazardous Materials; Decomposition; Toxicity; Bacteria; Jet Engine Fuels; Diesel Fuels*

## 14 LIFE SCIENCES

*Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.*

**19980001272** Federal Aviation Administration, Medical Div., Fort Worth, TX USA

**Bloodborne Pathogens in Aircraft Accident Investigation *Final Report***

Salazar, Guillermo J., Federal Aviation Administration, USA; DeJohn, Charles A., Federal Aviation Administration, USA; Hansrote, Ronald W., Federal Aviation Administration, USA; Key, Otis R., Federal Aviation Administration, USA; Nov. 1997; 14p; In English

Report No.(s): DOT/FAA/AM-97/21; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Occupational Safety and Health Administration (OSHA) amended 29 CFR Part 1910 in 1991 to include regulations addressing occupational exposure to bloodborne pathogens (BBP). The rule affects all employees who have the potential for occupational exposure to these pathogens. An accident scene presents significant challenges in terms of implementing a program which was primarily envisioned to affect personnel in "traditional" healthcare delivery facilities; the OSHA requirements now had to be met in the chaotic, inhospitable, and logistically difficult environment of an aircraft accident site. Unanticipated issues, such as heat-related conditions, performance of physically demanding work in cumbersome gear, biohazard trash disposal from remote sites, and a host of other problems had to be dealt with. The Federal Aviation Administration (FAA), in close cooperation with other Federal agencies, developed a training and administrative program to meet the requirements of the OSHA BBP rule as it relates to the unique environment of an aircraft accident site. The program has been implemented and successfully tested under actual field conditions at the sites of several major aviation accidents that have occurred recently. This article provides observations on the FAA's program and lessons learned from its implementation.

Author

*Safety; Aircraft Accidents; Pathogens; Health; Regulations; Education*

## 15 MATHEMATICAL AND COMPUTER SCIENCES

*Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.*

**19980000330** National Aerospace Lab., Flight Simulation Dept., Amsterdam, Netherlands

**Full Mission Simulation in a Research Environment**

Offerman, H. A. J. M., National Aerospace Lab., Netherlands; May 01, 1995; 20p; In English; Royal Aeronautical Society Conference on Flight Simulation Technology: Capabilities and Benefits, 17-18 May 1995, London, UK

Report No.(s): PB97-193296; NLR-TP-95197-U; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Dutch National Aerospace Laboratory NLR has developed during the last three years an advanced Full Mission Simulation capability for fast jet fixed wing and rotary wing aircraft. This Full Mission simulator, named the National Simulation Facility NSF, is created for research in training methodologies, investigation of simulation and simulator requirements for specific training tasks and to support industrial development of cockpit and aircraft systems. The current capabilities of the simulator also focuses on the F-16 Mid-Life Update configuration, but will be extended to accommodate manned helicopter simulation later this year. The latter will be directed towards the recently (by the Dutch Air Mobile Brigade) procured Boeing CH-47D Chinook medium-heavy transport helicopter, and the McDonnell Douglas AH-64D Apache attack helicopter. This paper will address the various technical aspects of the National Simulation Facility.

NTIS

*F-16 Aircraft; Flight Simulation; Mission Planning*

## 16 PHYSICS

*Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.*

**19980000198** NASA Lewis Research Center, Cleveland, OH USA

**Noise Reduction with Lobed Mixers: Nozzle-Length and Free-Jet Speed Effects**

Mengle, Vinod G., Allison Engine Co., USA; Dalton, William N., Allison Engine Co., USA; Bridges, James C., NYMA, Inc., USA; Boyd, Kathy C., NASA Lewis Research Center, USA; Nov. 1997; 14p; In English; 3rd; Aeroacoustics Conference, 12-14 May 1997, Atlanta, GA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): NAS3-27394; RTOP 538-03-11-00

Report No.(s): NASA/TM-97-206221; NAS 1.15:206221; E-10957; AIAA Paper 97-1682; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Acoustic test results are presented for 1/4th-scaled nozzles with internal lobed mixers used for reduction of subsonic jet noise of turbofan engines with bypass ratio above 5 and jet speeds up to 830 ft/s. One coaxial and three forced lobe mixers were tested with variations in lobe penetration, cut-outs in lobe-sidewall, lobe number and nozzle-length. Measured exit flow profiles and thrusts are used to assist the inferences from acoustic data. It is observed that lobed mixers reduce the low-frequency noise due to more uniformly mixed exit flow; but they may also increase the high-frequency noise at peak perceived noise (PNL) angle and angles upstream of it due to enhanced mixing inside the nozzle. Cut-outs and low lobe penetration reduce the annoying portion of the spectrum but lead to less uniform exit flow. Due to the dominance of internal duct noise in unscalloped, high-penetration mixers their noise is not reduced as much with increase in free-jet speed as that of coaxial or cut-out lobed mixers. The latter two mixers also show no change in PNL over the wide range of nozzle-lengths tested because most of their noise sources are outside the nozzle; whereas, the former show an increase in noise with decrease in nozzle-length.

Author

*Acoustic Properties; Jet Aircraft Noise; Noise Reduction; Uniform Flow; Multiphase Flow; Gas Jets; Low Frequencies; Subsonic Flow*

**19980000243** Old Dominion Univ., Norfolk, VA USA

**TBIEM3D: A Computer Program for Predicting Ducted Fan Engine Noise, Version 1.1**

Dunn, M. H., Old Dominion Univ., USA; Sep. 1997; 30p; In English; Original contains color illustrations

Contract(s)/Grant(s): NAG1-1940; RTOP 538-03-12-01

Report No.(s): NASA/CR-97-206232; NAS 1.26:206232; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This document describes the usage of the ducted fan noise prediction program TBIEM3D (Thin duct - Boundary Integral Equation Method - 3 Dimensional). A scattering approach is adopted in which the acoustic pressure field is split into known incident and unknown scattered parts. The scattering of fan-generated noise by a finite length circular cylinder in a uniform flow field is considered. The fan noise is modeled by a collection of spinning point thrust dipoles. The program, based on a Boundary Integral Equation Method (BIEM), calculates circumferential modal coefficients of the acoustic pressure at user-specified field locations. The duct interior can be of the hard wall type or lined. The duct liner is axisymmetric, locally reactive, and can be uniform or axially segmented. TBIEM3D is written in the FORTRAN programming language. Input to TBIEM3D is minimal and consists of geometric and kinematic parameters. Discretization and numerical parameters are determined automatically by the code. Several examples are presented to demonstrate TBIEM3D capabilities.

Author

*Computer Programs; Ducted Fan Engines; Engine Noise; Programming Languages; Noise Prediction*

**19980000970** College of William and Mary, Williamsburg, VA USA

**[Actuator placement for active sound and vibration control] Final Report**

1997; 1p; In English

Contract(s)/Grant(s): NAG1-1783

Report No.(s): NASA/CR-97-205835; NAS 1.26:205835; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Two refereed journal publications and ten talks given at conferences, seminars, and colloquia resulted from research supported by NASA. They are itemized in this report. The two publications were entitled "Reactive Tabu and Search Sensor Selection in Active Structural Acoustic Control Problems" and "Quelling Cabin Noise in Turboprop Aircraft via Active Control." The con-

ference presentations covered various aspects of actuator placement, including location problems, for active sound and vibration control of cylinders, of commuter jets, of propeller driven or turboprop aircraft, and for quelling aircraft cabin or interior noise. CASI

*Aircraft Noise; Noise Reduction; Vibration Damping; Actuators; Position (Location)*

**19980002162** Stanford Linear Accelerator Center, Menlo Park, CA USA

**Beam-beam simulations with non-Gaussian distributions for SLC and SLC-2000**

Bane, K. L. F., Stanford Linear Accelerator Center, USA; Chen, P., Stanford Linear Accelerator Center, USA; Zimmermann, F., Stanford Linear Accelerator Center, USA; May 1997; 4p; In English; 17th; IEEE Particle Accelerator Conference, 12-16 May 1997, Vancouver, Canada

Contract(s)/Grant(s): DE-AC03-76SF-00515

Report No.(s): SLAC-PUB-7508; CONF-970503-184; DE97-006830; No Copyright; Avail: Issuing Activity (Nat'l Technical Information Service (NTIS)), Microfiche

Due to various upstream beam manipulations, the longitudinal bunch shape at the interactions point of the Stanford Linear Collider (SLC) is highly non-Gaussian. In this paper, we report beam-beam simulations with realistic longitudinal bunch shapes for the present SLC parameters and for the SLC-2000 luminosity upgrade. The simulation results allow us to estimate the luminosity enhancement due to the pinch effect and to find optimum parameter settings for the bunch compressor and the linac.

DOE

*Linear Accelerators; Pinch Effect; Compressors; Beam Interactions*

## 19 GENERAL

**19980000887** Nanjing Univ. of Aeronautics and Astronautics, Nanjing, Jiangsu, China

**Journal of Nanjing University of Aeronautics and Astronautics, Volume 28 Monthly Report, Period ending 1996**

Azhou, Z., Nanjing Univ. of Aeronautics and Astronautics, Nanjing, China; Oct. 1996; 148p; In Chinese; Portions of this document are not fully legible; See also supplement, PB97-118889

Report No.(s): PB97-118871; No Copyright; Avail: Issuing Activity (Nat'l Technical Information Service (NTIS)), Microfiche

Contents include the following: Theoretical and Experimental Research; Research and Development; and Research Bulletins.

NTIS

*Research and Development; Aeronautical Engineering; Computer Networks*

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